POISONS

Poisons

Their Properties, Chemical Identification, Symptoms, and Emergency Treatments

by

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AND

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To

Gail and Fred

FOREWORD

Publication of this book is made by the authors as a public service.

As a member of the New Jersey State Police, Sergeant Vincent Brookes has recognized the necessity for a textbook on the subject of *Poisons* that would assist the police officer, as well as the layman, in recognizing immediate symptoms of poisoning. With this purpose in mind, and with the thought that in emergency cases action should be based on an intelligent knowledge of the proper treatment, Sergeant Brookes, assisted by Professor Hubert Alyea, has prepared this text.

It gives me great pleasure to recommend this book as a textbook for study, and as a book worthy of careful reading, particularly by police officers and members of all types of emergency corps who so ably assist the police.

CHARLES H. SCHOEFFEL,
Colonel and Superintendent,
New Jersey State Police.

PREFACE

Here in simple language, ready for rapid reference, with a minimum of technical details, is a handbook on the effects and emergency treatments of poisons. Since the majority of books on this subject are entirely too technical for the layman to gain a clear knowledge of what occurs in the human body when poisons are taken, we feel that this manual satisfies a real need.

Originally written for police, investigators, and peace officers, this material will, we believe, be of value also to physicians, nurses, chemists and pharmacists. It would even be valuable in the home.

The police officer, because he is very often at the scene within a few minutes after an occurrence, should be familiar with emergency treatments. At such a time he obviously cannot be expected to recall the mass of technical material found in most treatises on poisons. With this in mind, we have summarized in this handbook the important facts on the subject of poisons that he should remember in order to investigate intelligently and give help immediately. This book has developed out of the experience of one police organization; and it is our hope that, as a reference work, it will assist others in their development of an effective investigation procedure.

An introductory chapter deals with the factors that should be noted during a poison investigation. The next three chapters treat some one hundred and fifty common poisons, arranged alphabetically, describing their preparation and uses, chemical identification, the symptoms they produce, and the emergency treatments recommended for them.

There is a chapter on industrial poisons and one on special topics: food, plant, snake, and spider poisons. Certain special techniques are described: artificial respiration, use of the gas mask and the inhalator, and treatment for shock. A glossary of medical terms, a list of analytical reagents, and tables of weights and measures conclude the book.

The authors have striven wherever possible to designate trade names by capitalizing the first letter of the name. This is at best a difficult task and there may be instances where the convention has not been observed.

It is to be remembered that this is a book on the effects of poisons; in no sense should the stated normal doses be employed as a basis for prescriptions. Furthermore, fatal doses may vary considerably with the idiosyncrasy of the individual, and must be so judged.

Acknowledgment and thanks are due to the many persons who assisted us in formulating the original manuscript: to Dr. Robert P. Fischelis, Secretary and General Manager, American Pharmaceutical Association, Washington, D. C.; to John E. Hatrak, PhG. and Nelson J. Miles, PhG. for their valuable additions and suggestions; to Dr. Albert E. Edel, noted toxicologist, who has given us the benefit of his years of experience; and to Margery Lumsden and Jean Winkler for their clerical assistance.

We wish to thank Merck and Co., Inc. for allowing us to quote doses of drugs from *The Merck Index,* fifth edition. We are indebted also to Interscience Publishers, Inc., for permission to quote dangerous concentrations of industrial chemicals from M. B. Jacobs, *Analytical Chemistry of Industrial Poisons, Hazards and Solvents.*

Above all, this book was made possible by Colonel Charles H. Schoeffel, Superintendent of the New Jersey State Police, who alloted the time for the extensive work involved.

V.J.B.
H.N.A.

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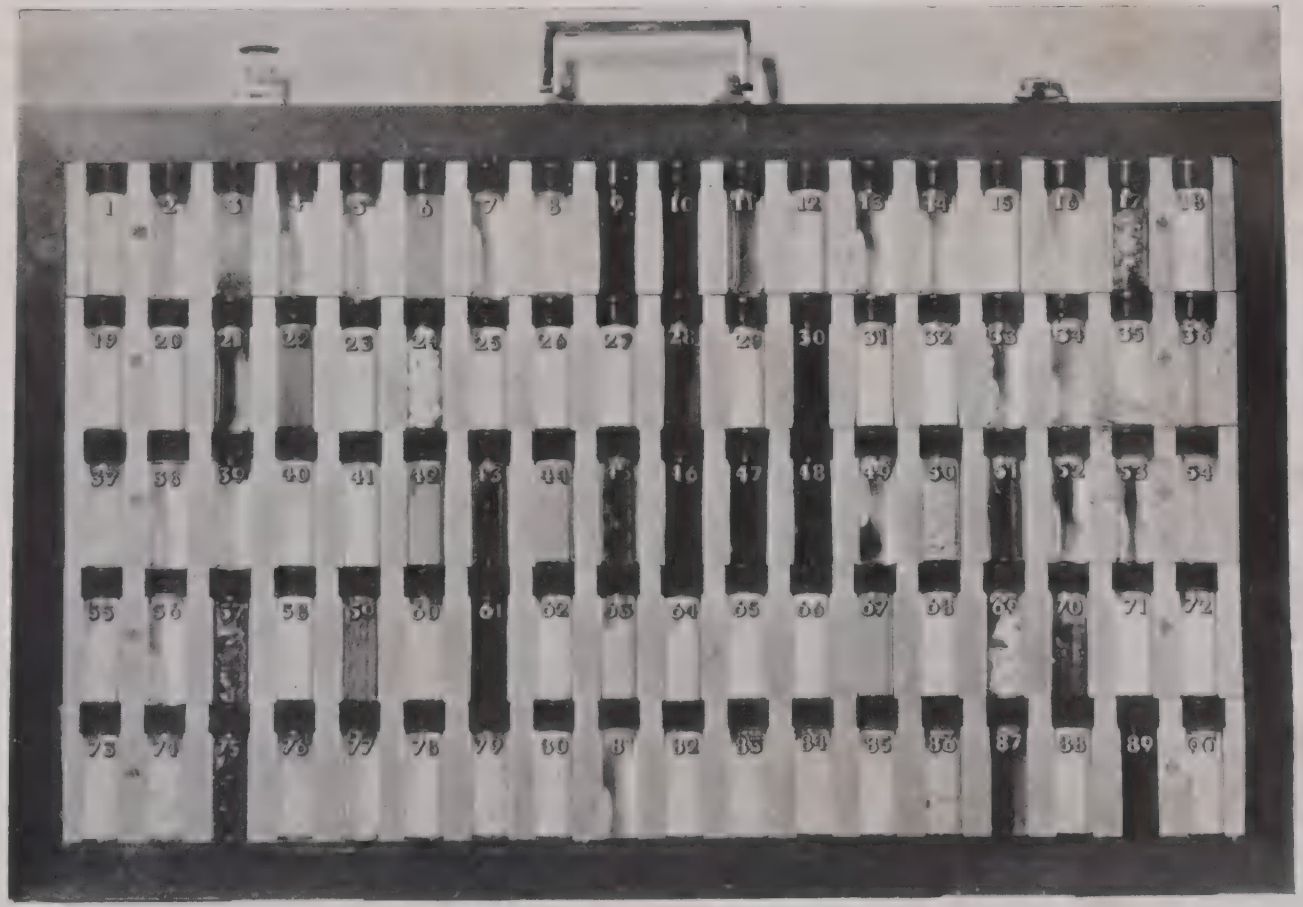

Instruction kit used by Sergeant Brookes in teaching Poison Investigation. One half the inside cover of kit contains samples of ninety common poisons, the other half gives poisons together with their antidotes.

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CHAPTER 1

Poison Investigation

Definition of a Poison. A poison is an agent which, when introduced into a living organism in sufficient amounts, may have an injurious or deadly effect, chemically producing a morbid or noxious condition.

Poison usually gets into the system through the mouth by swallowing (orally) or breathing, into the bloodstream (intravenously), under the skin (subcutaneously), or by absorption through the skin.

Kinds of Poisons. Poisons may be described in many ways: according to their chemical compositions, to their action on the body, to their physical characteristics, etc. The following is a simple and convenient list for reference:

Corrosive Poisons—which by their direct action destroy the tissues with which they come in contact.

Irritant Poisons—which inflame the mucous membranes by their direct action.

Systemic Poisons—which act on the nervous system or other important organs of the body without having any special corrosive or irritant effects.

Poisonous Gases—including carbon monoxide, chlorine, etc.

Foods which May Be Poisonous—which may contain (1) poisonous bacilli; (2) chemicals accidentally mixed in the foods, such as sodium fluoride, an ingredient in many roach and insecticide powders. (3) Also, fungus growths are sometimes mistaken for edible mushrooms.

Poisoning May Be Accidental, Suicidal, or Homicidal. Cases of accidental poisoning are far more numerous than those with suicidal or homicidal intent.

The following table indicates the general nature of such cases.

TABLE 1. DEATHS RESULTING FROM POISONING

Compiled from the Report of the Chief Medical Examiner of the City of New York for the year 1941.

Homicides

Illuminating gas	6

Suicides

Illuminating gas	387
Barbital and barbiturates	33
Lysol and phenol	20
Cyanide	15
Sodium fluoride	10
Arsenicals	7
Lye	4
Nembutal	3
Chloroform	2
Hydrochloric acid	2
Iodine	2
Morphine	2
Nicotine	2
Phosphorus	2
Salicylic acid	2
Amytal, gasoline, nitric acid, oxalic acid, phenobarbital, strychnine, and wood alcohol, 1 each	7
	500

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Wood alcohol	7
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Amytal, atropine, mercury bichloride, bismuth, carbon tetrachloride, lye, chloral, sodium dillantin, CN disinfectant, food, hydrocyanic acid, iodine, mercury salts, nitric acid, phosphorus, radium, salyrgan injection, sodium fluoride and toluol (occupational), 1 each	19
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Action of Poisons. The action of poisons may be local; or there may be a general systemic reaction after the poison is absorbed into the circulatory system; or the poisons may act in both ways.

Local Action. Corrosive poisons destroy or cause serious injury to the mucous membranes or tissues with which they come in contact. Other poisons set up a local inflammatory reaction in the mucous membrane of the alimentary tract; while still others act on the nervous system or other important organs of the body, such as the heart, lungs, kidneys, liver, etc., without having any special irritant or corrosive effects.

Systemic Reaction. Following the local action, the poison is usually absorbed into the bloodstream and produces harmful effects on the vital organs of the body. In fact, a poison attacks almost all the organs of the body to some degree; therefore, it is hardly possible to regard any individual poison as being entirely selective in its action, even when it appears to direct the brunt of its force on some individual system.

General Conditions that Control the Action of Poisons. The investigator at the scene of a poisoning should carefully consider certain conditions in relation to his diagnosis of the injured person. These conditions include:

Administration. Poison dissolved to form a solution, and taken by mouth (orally), will act more rapidly than if taken in solid form. Poisons administered intravenously or subcutaneously respond more powerfully than if taken by the mouth. When poisonous gases,

vapors, or sprays are inhaled, their absorption is rapid; and the effects great. It is also possible for poisons to be absorbed with fatal results by the skin or mucous membranes of the rectum or vagina.

Age. As a general rule infants and children are more susceptible to the effects of a poison than are adults. There are certain exceptions to this rule; for example, children are less susceptible to the action of belladonna, calomel, and strychnine.

Food. Food in the stomach has a marked influence on the effect of a poison: when the stomach is empty the effects will be rapid, but when the stomach is full there may be considerable delay in the action of a poison.

Habit. Certain poisons repeatedly taken in small doses build up an immunity, so that if the dose is gradually increased relatively large doses may in time be taken without toxic symptoms. With some poisons, their repeated use often leads to the development of the "drug habit." The tolerance for a poison, through habit, is not absolute, because toxic effects and death may result if the limit of the dose that is being taken habitually is slightly exceeded. This fact explains, for example, the death of morphine addicts from morphine poisoning.

A tolerance cannot be acquired for the majority of poisons: mercury or antimony, for example, cannot be taken even in small amounts for any length of time.

Health. Persons who are ill are found to be more susceptible to drugs than persons enjoying good health.

Idiosyncrasy. When an individual exhibits unusual reactions to a certain poison, he is said to have an idiosyncrasy. Some poisons will induce effects exactly opposite to those ordinarily produced; for example, the use of morphine in certain individuals may cause wakefulness rather than sleep.

Quantity. The quantity of a poison taken often bears a close relation to the effects produced. There is also an exception to this rule, because some substances when taken in excess cause vomiting, which results in much of the poison being expelled. The term "fatal dose," when applied to a poison, means the smallest amount known to have caused the death of an adult.

Hints for the Investigator. It is not necessary that the investigator become an expert on poisons, as he will have the knowledge and assistance of the medical examiner; but it will be a great help to him to know the symptoms of various kinds of poisoning, the amounts of specific poisons that will cause death, and the length of time that may elapse, after the poison has been taken, before death occurs. Very often additional knowledge relative to a poison is helpful, for example, where the poison is obtained, its chemical formula, others names it is known by, in which industries it is used, and what the antidote is.

A murderer does not use poisons having extreme odors, colors, or tastes, as they may tend to raise suspicion in the intended victim. A suicide, on the other hand, may take any poisonous substance regardless of its odor, color, or taste.

When deaths where poisoning is suspected are being investigated, sight and smell are of utmost importance. A thorough search and check should be made of the surroundings; the position and appearance of the body; the appearance of the skin in and about the mouth, lips, rectum, vagina, and the genitals; the pupils of the eyes—whether contracted or dilated; odors present; possible marks on the skin as a result of hypodermic needle injections; and the hands for the presence of objects. The latter aids the investigator in determining whether the object was grasped before death, or placed in the hand after death had occurred: if the fingers do not grasp the object tightly, the body was in death when the object was placed.

If it is learned that symptoms appeared soon after a drink or meal had been taken, the investigator should be extremely thorough in seeing that all liquids, foods, and medicines on the premises are preserved. A search should be made of the medicine cabinet, pantry, refrigerator, and even the refuse container. If many hours have elapsed after the meal was ingested, the possibility of food as the agent conveying the poison may be eliminated. Where symptoms of poisoning have been observed, the investigator can reasonably assume that the victim had taken the poison from one-half to one hour before the first symptoms appeared, although in strong acids and alkalies symptoms are present immediately.

The presence of poison must be proved. Probably one of the best

methods is by chemical analysis. This can be made from foods or liquids suspected, or from the contents of the stomach following the post-mortem examination. A specimen of the vomitus should be taken for analysis.

A careful questioning of persons should be made, especially of those who saw the victim shortly before his death. Check those who might have had a motive to do away with the deceased, particularly those benefitting from the death. A thorough search should be made for notes or letters of departure to friends and relatives. Many times these letters are hidden away with bits of other evidence to avoid unpleasant publicity. Check the history of the victim to learn whether there was any reason, fancied or real, for him to destroy himself.

Many times persons attempting to commit suicide try more than one method before finally succeeding. For example, a person may try one method, then jump out a window; or after taking a poison, may hang or shoot himself. When preparations have been made to make death certain, such as attaching a tube to a gas jet and inserting the opposite end in the nose or mouth and sealing cracks and openings around the doors and windows to prevent the escape of gas, suicide can be suspected; but not absolutely proved, for cases are sometimes made to look suicidal by the person committing the crime. If the victim, after taking the above precautions locks himself in a room in such a manner that there could be no possibility of a homicide, then, and then only is suicide to be accepted as a fact.

First Aid. The investigator should familiarize himself with the general symptoms of various kinds of poisoning and emergency treatments, so that he can speedily render first aid, if it is not too late for such treatment. The necessary information is supplied in chapters 3, 4, 5.

Rigor Mortis. After death the body develops a stiffness known as rigor mortis. This is the result of chemical changes in the muscle protoplasm. After death the reaction is slightly alkaline for a short period, and as long as this persists the muscles are flexible. Two to six hours after death the reaction changes from alkaline to acid, at which time the rigor begins to develop in the face, jaw, upper extremities, trunk, and the lower extremities, occurring in about the

sequence named. The process completes itself in approximately two hours. The muscles not only become rigid but shortened as well. It is not easy to change the position of the body after rigor has developed, because of the stiffness. This stiffness lasts from twelve to forty-eight hours, until the muscles again become alkaline from further chemical change, after which the rigor slowly passes off. The body loses its rigidness in about the same sequence it appeared.

Conditions alter the onset, persistence, and disappearance of rigor mortis. Where the individual died in convulsions or in strong muscular activity, the rigidity may appear within an hour. There are cases recorded where the entire body became rigid almost immediately following death. Individuals with developed muscles take on post-mortem rigor more slowly than others and retain it for a longer time. Those with poorly developed muscles, and also thin people and infants become stiff more rapidly and lose the rigidity faster. Heat speeds the onset of rigidity and hastens its ending. Cold hastens the onset but retards its dissolution, so that stiffness is retained for many days. In some cases it may be necessary to tell true rigor mortis from the stiffness resulting from cold.

The eyeball glistens immediately following death, and within a few hours is covered with a thin transparent film of dried secretion.

Publicity. Something should be said regarding the publicity given in the investigation of poisoning cases. Many druggists, for instance, have received public blame erroneously, and as a result have lost their business because the facts of the case were not given to the newspaper in proper detail. There is a case on record of a man who received from a druggist strychnine on a doctor's prescription, with instructions for safe dosages. The victim, getting good results with the properly administered drug, figured he would have quicker results by taking larger doses, and in doing so he gave himself an accumulated overdose, which proved fatal. The state held the druggist; but upon investigation found the prescription compounded perfectly. However, the unpleasant notoriety forced the druggist out of business. If the facts had been explained in the first news release, a false impression, supplemented by false fears that they might be future "victims," would not have seized the public, and they would not have lost faith in the druggist's reliability.

CHAPTER 2

Basic Information for the Investigator

1. Chemical Information

Chemical Elements. A brief description of chemical formulas is in order at this point. All matter is built up of tiny particles called atoms of elements. There are atoms of copper, atoms of sulfur, atoms of iron, and so forth. The chemist represents each of these elements by a kind of chemical shorthand, called chemical symbols. The symbols encountered in this book are:

Ag	silver	Ca	calcium	K	potassium	Pb	lead
As	arsenic	Cl	chlorine	Mn	manganese	S	sulfur
B	boron	F	fluorine	N	nitrogen	Sb	antimony
Ba	barium	H	hydrogen	Na	sodium	Zn	zinc
Bi	bismuth	Hg	mercury	O	oxygen		
C	carbon	I	iodine	P	phosphorus		

Although there are about ninety-two different elements in the world, with corresponding symbols, only a few are really common. Thus one-half of all the earth's crust is oxygen; one-quarter is silicon. The human body is chiefly oxygen (64%), carbon (20%), hydrogen (10%); the rest is calcium (2%), nitrogen (2%), phosphorus (1%); all other elements add up to only 1%.

Atoms Combine to Form Compounds. Elements may combine chemically. For example a particle of carbon monoxide, the deadly gas present in automobile exhaust gas, contains one atom of carbon and one atom of oxygen. Carbon monoxide is written CO; this is

called a molecule of carbon monoxide. A molecule of water contains two atoms of hydrogen and one atom of oxygen, written H_2O.

Some molecules contain more than two elements. For instance, sodium carbonate or washing soda, Na_2CO_3, contains sodium, carbon, and oxygen; and sodium bicarbonate or baking soda, $NaHCO_3$, contains sodium, hydrogen, carbon, and oxygen; each of these compounds contain six atoms.

Sometimes the different ratio of atoms in the molecule forms different compounds. As examples, there are sodium nitrite, $NaNO_2$, with two atoms of oxygen and sodium nitrate, $NaNO_3$, with three. Organic materials, such as the alkaloids, may have a great number of different atoms. Morphine, for instance is $C_{17}H_{19}O_3N \cdot H_2O$, which means that it contains water (H_2O) in the compound itself, together with 40 other atoms. Alkaloids containing acids (groups such as morphine sulfate) are prepared in such a way as to make them water-soluble. Also the way atoms are joined together in space often changes their properties. There are, for instance, 32 different kinds of sugar, like glucose or grape sugar, with the formula $C_6H_{12}O_6$.

Acids and Alkalies. Some compounds are closely related. This causes them to react chemically alike, and makes their symptoms and treatments similar.

Acids all contain hydrogen, turn litmus pink, and are bitter to the taste; for example, HCl, hydrochloric acid; H_2SO_4, sulfuric acid; HNO_3, nitric acid. The acids just mentioned are very powerful acids, and seriously corrode and damage human tissue, often causing death. Other acids are relatively harmless in dilute solution. Carbonic acid (H_2CO_3) for instance forms the fizz in soda water and soft drinks; and vinegar contains about 5% acetic acid, ($HC_2H_3O_2$).

Alkalies, also called bases or hydroxides, all contain the hydroxyl group (OH), turn litmus blue, and feel soapy: for example, sodium hydroxide, NaOH; potassium hydroxide, KOH. These two are powerful, corrosive alkalies called caustic alkalies. These caustic alkalies burn and destroy human tissue. (The word caustic is derived from the Greek *kaustikos,* meaning burn). Other alkalies are

relatively weak, for example, calcium hydroxide or limewater, $Ca(OH)_2$; dilute ammonium hydroxide, NH_4OH.

Neutralization to Form Salts. Salts are compounds formed when acids react with alkalies; this process is called neutralization. The chemist represents this by means of a chemical equation. For instance, when sodium hydroxide (lye) reacts with hydrochloric acid, common table salt is formed. The chemical shorthand for this reaction is:

sodium hydroxide	+	hydrochloric acid	forms	table salt	+	water
NaOH	+	HCl	forms	NaCl	+	H_2O

This process of neutralization is utilized in treating for poisoning from acids, or from bases. If a strong, powerful acid such as sulfuric acid has been swallowed, a weak alkali such as limewater is administered, and chemically neutralizes the acid:

Swallowed accidentally	+	*Administered as antidote*	forms	*Harmless compounds*
Sulfuric acid	+	Limewater	forms	Calcium sulfate + water
H_2SO_4	+	$Ca(OH)_2$	forms	$CaSO_4 + 2H_2O$

If on the other hand a powerful caustic alkali such as sodium hydroxide has been swallowed, the patient is given a weak acid such as citric acid in fruit juices, or acetic acid in vinegar; this nullifies the damaging effect of the caustic by neutralizing it:

Swallowed accidentally	+	*Administered as antidote*	forms	*Harmless compounds*	
Sodium hydroxide (lye)	+	Acetic acid (*in vinegar*)	forms	Sodium acetate (*a salt*)	+ water
NaOH	+	$HC_2H_3O_2$	forms	$NaC_2H_3O_2$	+ H_2O

Notice that only weak acids or weak alkalies are administered. **Never give the patient a strong acid or a strong alkali: it will do as much harm as the original poison.**

Carbonates and Acids. A carbonate should never be administered if the acid poison is concentrated, because the carbon dioxide gas may be evolved so vigorously that it damages the already injured tissue of the stomach.

If only a very dilute solution of an acid has been swallowed, certain carbonates may be used to nullify the effect of the acid. While chemically speaking this is not strictly neutralization as defined in a preceding paragraph, its effect of destroying the acid is the same. This is best effected by the administration of weak alkalies, as the carbonates, or calcined magnesia. In an emergency, soap suds or whiting may be used. It must be remembered that all antidotes given should be dissolved in large amounts of fluid (water or milk).

Note: Never use washing soda; it acts like a strong alkali. The carbonates use up the acid and form carbon dioxide.

Swallowed accidentally	+	*Administered as antidote*	forms	*Harmless compounds*			
Very dilute (5%) hydrochloric acid	+	Calcium carbonate	forms	Calcium chloride	+ Water	+	Carbon dioxide
Dilute HCl	+	$CaCO_3$	forms	$CaCl_2$	+ H_2O	+	CO_2

Sources of Drugs. Mineral, vegetable, or animal substances that may irritate, soothe, or otherwise affect the human tissue are used as drugs. (1) Minerals treated chemically produce acids, alkalies, and salts. (2) Vegetables yield drugs from various sections of the plant such as the flowers, the fruit, the sap, the roots, the bark, and in many instances from the entire plant. The crude drug obtained from the plant is not often used; usually it is treated by physical or chemical methods. For instance, the crude drug from which the alkaloids are prepared is treated with various solvents which extract or dissolve out the active ingredients (for example, morphine from crude opium); and these active ingredients may themselves later be treated chemically to produce other drugs (for example, apomorphine from morphine). (3) Animal organs from which drugs are prepared include the pancreas, the thyroid, and other glands.

Important General Drugs. *Alkaloids* are found in plants, or are made chemically from plant extracts. They consist largely of carbon, hydrogen, and nitrogen. Alkaloids do not dissolve readily in water, but their salts do (for example, morphine sulfate, cocaine hydrochloride); and these salts are the preparations generally used in medicine.

Balsams are resins containing cinnamic or benzoic acid and their esters.

Enzymes or ferments are the active principles of many vegetable and animal substances, and are capable of producing definite, specialized effects.

Glucosides form sugar when decomposed by heat, acids, or bacteria. These glucosides are neutral, that is, neither acid nor alkaline. Their names usually end in "in."

Hormones are active principles found in animal glands, such as the pituitary, the adrenal, the thyroid, or the pancreas. These glands secrete the active substances that influence the rate of development, growth, and life processes of a person.

Oils are usually greasy liquids of vegetable, animal, or mineral origin. Of these, olein is the chief constituent of vegetable oils; palmitin is another important oil; and stearin, or tristearin, is a pearly white, crystalline substance found in the fats of both animals and plants. Mineral oils, obtained from petroleum, are also of vegetable origin, having been produced in primeval bogs from decaying plants. Some oils evaporate readily; these are the volatile oils. Others are called fixed oils.

Oleoresins are compounds formed from resins combined with essential oils, and extracted from the plant with ether, alcohol, acetone, etc. for medicinal purposes.

Saponins are glucosides having soapy properties, foaming when mixed with water. Toxic varieties are called *Sapotoxins.*

Tannins are found in the bark of many trees.

Household Chemicals. Certain types of chemicals may be suspected in various patented mixtures found about the household. Some of these follow:

Cleaners: ammonia, lye (sodium hydroxide), phenol (carbolic acid), phosphates, washing soda (sodium carbonate), tri-basic sodium phosphate.

Fly Poisons: arsenic compounds, fluoride compounds, D.D.T.

Insect Powders: D.D.T. fluorides, lead compounds, lime, Paris Green (arsenic), phosphorus, pyrethrum, thallium compounds.

Laxatives: calomel, phenolphthalein.

Liniments: alcohol, capsicum, chloroform, menthol, oil of wintergreen, oil of mustard, turpentine.

Moth Repellants: camphor, cedar gum, naphthalene, paradichlorobenzene.

Ointments: camphor, phenol, salicylic acid, turpentine, capsicum, oil of wintergreen, oil of mustard.

Soothing Syrups: opium derivatives, chloroform, paregoric, camphorated tincture of opium, Hoffman's Anodyne.

Doses. Poisons do not always injure or kill; in fact for any poison there may be some small concentration that is beneficial to the body. Accordingly poisons are often found in medical preparations, and are therefore the source of accidental poisoning. The quantity of these substances to be safely administered as medicines of course varies greatly with the disease, the weight, sex, age of the individual, and so on. The average adult doses given in this chapter have been taken from the Merck Index (Fifth Edition, 1940). For a child, apply Cowling's rule:

$$\text{Child dose} = \frac{\text{age on next birthday}}{24} \text{times adult dose.}$$

Thus a child who will be six on the next birthday should take $\frac{6}{24}$ or $\frac{1}{4}$ of the prescribed adult dose. Fatal overdoses would vary greatly in different cases, and are stated here only as an approximate guide for the investigator.

In cases where several concentrations of the same medicine are on the market, the investigator should be careful to determine which one has been taken. As examples, tincture of iodine may contain anywhere from 2% to 16% iodine, 7% being the most common; creosote from wood tar is occasionally prescribed, but creosote from coal tar cannot be taken without harmful results; concentrated acids are violently corrosive, but the same acid in diluted form may not be very dangerous.

2. Identification by Chemical Means

The accurate identification of a poison should be done only by a toxicologist trained and skilled in chemical analysis. He will examine the organs, excretions, and tissues of the body for poisons. Set all excretions and vomitus aside for him in scrupulously clean airtight glass jars; never add preservatives, for this will ruin the chemical tests he is to make.

It often happens, however, that the substance swallowed must be quickly identified, before a toxicologist arrives. *Here is the patient. Here is the vial of white powder he has swallowed. We think it is white arsenic. Is it?* To answer just such questions, this chapter gives simple, rapid chemical tests. Their very simplicity means that they are not so conclusive as the painstaking analysis that the toxicologist will later carry out.

The appendix has a complete list of chemicals required to carry out all tests in this book. The investigator should prepare a kit of these chemicals; and especially practice the tests on known samples, so that he is familiar with them if ever called to put them to actual use.

If the police officer intends to carry out the chemical tests described in this section it will be advisable for him to receive expert instruction for several weeks by a trained toxicologist or chemist in these special techniques.

Preliminary Examination of Poison. (1) First examine the label on the bottle or container that held the poison. Consider the source of the poison: that is, if it is rat poison, suspect arsenic; if paint, suspect lead, and so on. (2) Next try to estimate whether the poison is still in the stomach, or has passed into the intestines or bloodstream: consider, for instance, how much time has elapsed since the poison was taken, whether it was taken as granules (slowly absorbed) or as a water solution or alcoholic solution (quickly absorbed). This will tell you how quickly you must act; for example, if cyanides have undoubtedly been taken, act without a moment's delay; for with that poison death follows swiftly. (3) Then examine the poison itself, noting whether it is liquid or solid; whether it is an amorphous powder or crystalline needles, flakes or scales; whether

it is moist (deliquesces). (4) Notice its color, remembering that white substances are easily discolored by aging or by impurities. (5) Sniff, but do not inhale it, remembering that characteristic odors may be hidden by other smells, or that the poison may have evaporated. (6) Test it with moistened litmus paper: paper turning pink indicates an acid; paper turning blue indicates an alkali.

General Technique. There are several precautions that any investigator must observe in carrying out the tests: (1) Most important is extreme cleanliness; the slightest trace of foreign matter will ruin a chemical test. (2) Never taste anything; assume that all chemicals are poisonous; wash hands thoroughly before turning to the patient after carrying out these chemical tests. (3) When using the alcohol burner, heat gently; keep the mouth of the tube pointed away from your own face or other persons; keep your hand away from the base of the lamp, where concentrated acid might spill if the tube breaks. (4) Use small quantities of reagent: a few drops often give better color reactions than a tubeful.

Preparing the Unknown for Analysis. Following the preliminary examination, prepare the unknown sample and turn to the individual tests given under each poison. **Important: Use only a small bit of your unknown sample; save the rest for later tests; and above all leave the majority of the sample for the toxicologist to test.** The unknown is either the original poison, the vomitus, or the breath. Examination and testing of tissues of the body should be left to the toxicologist. The sample must be properly prepared before the tests can be carried out.

A Gas: If the unknown is a gas, its identity can often be determined by its odor, as most gases have characteristic odors. However, test papers may be used and are very convenient. The gas may be tested directly, or dissolved in water and the solution tested.

A Liquid. Test directly.

An Inorganic Solid. Dissolve a pinch in 10 cc. water, heated if necessary to boiling; usually sufficient solid will pass into solution to test directly.

An Alkaloid. Test a pinch of the unknown for solubility in water (for example, alkaloid salts). If it appreciably dissolves, test di-

rectly. If it does not dissolve, shake up a small portion with ethyl alcohol (95%) and test the clear liquid that remains after any undissolved solid has settled. A third procedure for putting sufficient alkaloid into solution is to add dilute hydrochloric drop by drop to a pinch of the powder, until the powder goes noticeably into solution (it may completely dissolve); then use the clear liquid for the color tests.

The above procedures are much more simplified than the elaborate

TABLE 2. SPOT TESTS FOR METALS

SALTS OF	AMMONIUM CARBONATE	AMMONIUM SULFIDE	POTASSIUM IODIDE
Antimony	white	orange	.....
Arsenic	.....	yellow; forms slowly; sol. in excess	.....
Barium	white	.....	.....
Bismuth	white	brownish black	dark brown; sol. in excess
Cadmium	white	yellow	.....
Copper	light blue	black	brown
Lead	white	black	bright yellow
Mercuric	white	black	green, turning red
Mercurous	white	black; brown to black	green; yellow-red mixture "parrot color"
Silver	white	black	white turning purplish in light
Zinc	white	white; sol. in excess	.....

techniques that the toxicologist must use to put the alkaloids into solution, but will serve the purpose for color tests.

Other Organic Solids. Dissolve a pinch in 10 cc. water heated to boiling; or 10 cc. alcohol heated to boiling. If neither solvent dissolves the solid, shake with ether.

Spot Tests for Metals. On a porcelain plate place 3 separate drops of the aqueous solution of unknown, or 3 pinches of solid unknown. Add 1 drop of aq. ammonium carbonate to sample 1; 1 drop of aq. ammonium sulfide (white, not yellow) to sample 2; and 1 drop of aq. potassium iodide to sample 3. Colors obtained with inorganic salts of various metals are found in Table 2. Sometimes no results are obtained if the metals are in organic compounds.

Flame Tests. Some metals in salts can be easily identified by the color they impart to flames; the test follows. Melt the tip of a 6-inch glass rod, and while rod is soft push in about ⅛-inch of a 3-inch platinum wire. Use this for flame tests. Dip the wire into dil. HCl and hold in the flame. Repeat until the yellow color of the sodium flame no longer persists. Now dip the wire into a solution of the unknown, and hold in the flame. Hydrochloric acid is used since it forms chlorides, which volatilize easily. The various metals are indicated by characteristic colors as follows:

Red	strontium, lithium
Orange red	calcium
Yellow	sodium
Green	barium
Greenish-blue	copper
Violet	potassium

Spot Tests for Alkaloids. Pure samples, water solutions of alkaloid salts, or the solutions prepared as described on page 16, will give the tests as shown in Table 3. In each case a few drops of unknown solution is added to an equal quantity of reagent on a porcelain plate.

TABLE 3. SPOT TESTS FOR ALKALOIDS

COLOR	DILUTE H_2SO_4	CONCENTRATED HNO_3	FROHDE'S REAGENT	MANDELIN'S REAGENT	POTASSIUM FERROCYANIDE
			0.2g. molybdic acid in 100 cc. conc. H_2SO_4	1g. ammonium vanadate in 100 cc. conc. H_2SO_4	
Red	morphine (turns violet)	brucine [red changing to yellow]	brucine	morphine	.....
Orange	.....	morphine	.....	.....	caffeine
Yellow	aconite (turns violet)	strychnine (straw-colored) brucine (see above)	aconitine; codeine (turns green then blue)	.....	.....
Green	codeine (brownish)	aconite (yellowish, cold)	apomorphine cocaine (turns blue); quinine	cocaine (bluish)	quinine
Blue	.....	.....	codeine cocaine (from green) morphine (from all colors)	.....	morphine (from white); strychnine
Violet	.....	.....	morphine (then turns all colors)	strychnine (to rose on adding NH_4OH; slow changes)	.....
Brown	aconite; atropine (warm)	.....	.....	codeine (from olive)	.....
Colorless	caffeine cocaine quinine strychnine none	atropine caffeine cocaine codeine quinine none	atropine nicotine strychnine none	aconite atropine caffeine quinine none	aconite atropine cocaine codeine none

3. Symptoms

There are times when it is exceedingly difficult to identify a poison through the symptoms it produces, because the symptoms may closely resemble those produced by a certain illness. For example peritonitis, an acute indigestion, or intestinal obstruction produce symptoms resembling those of an irritant poison. Apoplexy, epilepsy, or cerebral hemorrhage symptoms simulate those of narcotic poisoning. Opium poisoning may be mistaken for apoplexy, and strychnine poisoning for tetanus.

One may be suspicious when an individual apparently in good health suddenly exhibits marked pathological symptoms that speedily become extreme. There are no definite and established rules to determine poisoning except by chemical analysis of the vomitus, feces, urine, or of the food present or suspected.

Certain general symptoms suggest the possibility of a number of poisons, without definitely establishing any specific one. The following items should be closely observed:

1. Sudden Death: some poisons act swiftly. Tie a string firmly around the patient's finger; the end becomes purple if the patient is living.

2. Eyes: general vision impaired, pupils contracted or pupils dilated.

3. Breath: odor of the poison.

4. Mouth: dry, or wet (saliva runs), or bleached.

5. Skin:
   a. Dry.
   b. Rash.
   c. Cyanosis; blue skin caused by insufficient amount of oxygen as a result of shallow breathing. Suspect lead compounds, corrosives, or poisonous foods.
   d. Tissue damage; suspect strong acids or alkalies. When strong acids or alkalies are swallowed the vomitus is brown or black matter, mixed with blood. Portions of mucous membranes of the stomach are usually present in the vomitus.

6. Nausea, vomiting, or diarrhea: from gastro-intestinal irritants. Suspect metals or poisonous foods.

7. Other reactions of the patient:
   a. Stupor. Induced by narcotics or alcohol.
   b. Delirium.
   c. Paralysis.

Table 4 lists the poisons that are associated with these symptoms.

TABLE 4. SYMPTOMS OF COMMON POISONS

1. Sudden Death:

aconite	cocaine	oxalic acid
ammonia (concentrated)	cyanides	phenol
barium compounds	ether	strychnine
carbon dioxide	hydrogen sulfide	certain poisons in large dose
chloral hydrate	nicotine	

2. Eyes:

General Vision Impaired	*Pupils Contracted*	*Pupils Dilated*
camphorated oil	barbital	aconite
camphoric acid	chloral hydrate	aconitine
ergot	morphine	atropine
foods (at times)	mushrooms (at times)	barbital
lead salts	nicotine (1st stage)	belladonna
mushrooms (at times)	opium	chloroform (liquid)
thallium salts		cocaine
		hydrogen sulfide
		iodine
		nicotine (later)
		opium
		sodium nitrite
		wood alcohol

3. Breath odors:

acetic acid (vinegar)	chloroform	iodine
ammonia	cresols	laudanum
camphor	cyanides (bitter almonds)	phosphorus
chloral (bananas or pears)	ether	thallium salts

4. Mouth

Dry	*Wet*	*Bleached*
atropine	anything that destroys the membranes of the mouth, i.e. ammonia, arsenic, etc.	aconite (numb)
belladonna		ammonia (flakes)
opium		mercury bichloride
		nitric acid (yellow or white, soft)
		phenols or cresols (hard, white)
		potassium carbonate
		sodium carbonate

5. Skin

Dry	*Rash*
aconite	antimony (like small pox, rare)
alcohol	arsenic (like eczema or scarlet fever)
antimony	belladonna (like scarlet fever rash)
nicotine	chloral hydrate (urticuria)
most poisons during stage of collapse	croton oil
	opium (itching, rose-patches, rare)
	turpentine

Cyanosis (Skin and lips blue)

acetanilid	phenacetin
aniline dyes	all substances listed below under item 6
antipyrine	

Tissue Damage

acetic acid	lysoform
ammonia water	lysol
carbolic acid (white to brown)	nitric acid (yellow)
chlorine water	oxalic acid
creolin	phosphoric acid
creosote	phosphorus
cresol	potassium hydroxide
croton oil	sodium hydroxide
formaldehyde solution	sulfuric acid (white to brown)
hydrochloric acid (yellow)	turpentine
hydrofluoric acid	

6. Nausea—Vomiting—Diarrhea

all acids and alkalies
aconite
alcohol (diarrhea at times)
ammonium hydroxide (bloody vomitus)
antimony compounds (white, stringy bloody vomitus)
apomorphine
arnica
arsenic (brown, bloody vomitus)
barium salts
bismuth
calcium hydroxide
camphorated oil
chlorine water
chloroform
copper salts
corrosive sublimate (green, bloody stools)
cresols
croton oil
digitalis (grass-green vomitus)
ergot
food poisoning
formaldehyde solution
gasoline
hydrogen sulfide
iodine
lead compounds
lysol
mercury
mushroom poisoning
opium
phosphorus (green-brown vomitus, luminous in dark)
picric acid
potassium chlorate
potassium carbonate
potassium hydroxide
silver nitrate
sodium fluoride
sodium hydroxide
thallium salts
turpentine
zinc salts

7. Other Reactions: *Stupor*

acetanilid
aconite
aconitine
alcohol *
allonal
aminopyrine
amytal
aniline dyes
antipyrine
apomorphine
atropine
barbital
belladonna
bromides
chloral hydrate
chloroform
codeine
ether
formaldehyde sol.
gasoline
heroin
medinal
morphine
opium
paraldehyde
phenacetin
phenobarbital
sulfonal
trional
turpentine

* Do not confuse a fractured skull or concussion with alcoholic poisoning. There have been instances where an individual who was thought

Delirium

alcohol	camphor
belladonna (happy, noisy)	strammonium

Paralysis

aconite	lead
arsenic	

4. Emergency Treatment

Send for a physician at once. Make this your first and most important duty.

Gas. If the poison is a gas, the immediate need is fresh air and artificial respiration. If an inhalator is available it should be used in conjunction with artificial respiration to supply a greater concentration of oxygen, plus 5 to 7% carbon dioxide, which is usually the mixture found in the inhalator tanks. When the patient revives keep him quiet and warm. See page 174.

External Burns. If the poisoning is external, such as a burn on the hand from concentrated acid, the poison is to be washed with (1) plenty of water; or (2) if not water-soluble, with soap and water; or (3) with alcohol. Then the remaining poison is neutralized: (1) if it is an acid burn, wash with milk of magnesia, lime-water, chalk, whiting, sodium bicarbonate, much soap and water (page 10); (2) if it is an alkali burn, wash with lemon or other citrus juice (citric acid), or with vinegar (acetic acid).

Poison from Bite or Injection. If the poison has come from a bite or an injection, the poison can sometimes be checked from spreading throughout the body by properly applying a tourniquet or a restricting band tightly above the wound. This retards the absorption of the poison by the blood. The poison may be removed by sucking, if the operator has no cuts in the mouth. **Note: When using a restricting band, care should be exercised to loosen it every 15 minutes for 2 or 3 seconds to prevent gangrene.** The poison may

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drunk was lodged in a local jail; and only later upon examination was the individual found to be suffering actually from a fractured skull or a concussion.

also be destroyed chemically; for example, formic acid in ant stings is neutralized by applying ammonia water.

Poisoning by Swallowing. By far the majority of poisons, however, will have reached the stomach. Treatment in this case follows the steps:

1. *Send for a Physician at Once.*
2. *Emetics to Produce Copious Vomiting.* This operation removes the bulk of the poison.
3. *Antidotes.* Chemicals are used to destroy any poison still remaining in the stomach. Since the antidote itself may be poisonous, and often cannot be left in the stomach, the antidote is added to the washing solution if an emetic is used. The antidote solution is swallowed between the intervals of vomiting. (See page 26.)
4. *Demulcents.* Substances like milk or oatmeal gruel, which form a soothing, protective coating over the irritated membranes.
5. *Special Treatments.* Keep the patient warm and quiet, elevate the feet, give a stimulant (indicated under each poison). Eventually cathartics may be given to remove poisons which have already gone into the intestines; generally by this time the physician will have arrived.

Each of these steps will be taken up in turn in the following paragraphs.

Send for the Physician. It is well to remember when sending for a physician to give the exact location where the victim can be found. It may also be beneficial to inform the doctor what the injury is, and if you know, what type poison was taken.

Emetics. Emetics are medicines or substances that produce vomiting. In this way the poison is washed out of the stomach. The sooner the emetic is given, the better the results will be; and even though several hours have elapsed it is still wise to give an emetic, since some poisons are not readily absorbed. **Avoid emetics if strong acids or alkalies have been taken, since vomiting may rupture the already damaged walls of the stomach and esophagus.**

It must be emphasized that a single vomiting does not clear the

stomach; **the vomiting must be repeated several times.** Induce vomiting repeatedly until the vomitus fluid is clear. If vomiting does not occur after the emetic has been given, tickle the throat. If the patient resists feeding the emetic, place your two thumbs inside his throat (so he cannot bite), depress the tongue with the handle of a spoon, and force-feed.

Some common emetics follow:

1. *Dry mustard.* 1 teaspoonful of dry mustard in 1 glass of lukewarm water, give about ¼ of this amount and follow with a glass of warm water. Repeat this same procedure again in 1 minute. Continue until the entire glass has been given.

2. *Salt.* 2 tablespoonfuls of salt in 1 glass of lukewarm water. Repeat, giving a glass of warm salt water every minute until 4 glassfuls have been given.

3. *Soapy water.* Shake a piece of mild soap in a bottle of warm water to make suds. Give about ¼ of a glassful, and follow with a glassful of warm water. Continue until 4 doses have been taken.

4. *Zinc sulfate (white vitriol).* Dissolve about 20 grains (about as much as can be heaped on a 25-cent piece) in a glass of water. Have the patient drink this, followed by a cup of warm water. Repeat until 3 doses (total 60 grains, no more) have been given. Do not use when the poison taken is an irritant poison.

5. *Pulverized ipeca* (ipecacuanha). Good for children. Mix 20 grains with 1 cup of water; it will form solid particles suspended in water, like mustard. Give a total of 3 glassfuls (total 60 grains, no more).

6. *Tickling the throat.*

7. *Copper sulfate.* Dissolve ½ gm. in 1 glass of warm water. Have the patient drink this, followed by a glass of warm water. Repeat in 15 minutes until 3 doses have been taken. Do not use when the poison taken is an irritant poison.

Antidotes. An antidote neutralizes the action of a poison either by altering its physical state or its chemical composition, thereby preventing its action or retarding its absorption. The compounds formed by antidotes are very often only slightly less toxic than the original poison, or they may become poisonous by remaining in the

stomach, therefore **antidotes should be a part of the lavage or given with the emetics.** When emetics are employed, the antidotes may be given between the intervals of vomiting. Generally, antidotes are given repeatedly at short intervals. Tannin is one of the most valuable antidotes and acts as a precipitating agent. Tannin may be given in the form of very strong hot tea.

Antidotes for specific poisons. Following are a few antidotes that are useful against specific poisons:

Acids .....Baking soda, soap, burnt magnesia, chalk
Alkaloidal poisons ..About 15 drops of tincture of iodine in ½ glass of water
Alkalies .....Vinegar or lemon juice
Barium .....Magnesium sulfate (Epsom salts)
Glucosides .....Potassium permanganate, sodium acetate
Oxalates .....Lime water, whiting, or chalk
Phosphorus .....Copper sulfate

A multiple antidote. A good multiple antidote to have handy is a saturated solution of sulfate of iron 100 parts, water 800, magnesia 88, animal charcoal 44 parts. It is best to have magnesia and animal charcoal mixed together in the dry state and kept in a well corked bottle. When required for use the saturated solution of iron is mixed with eight times its bulk of water and the mixture of charcoal and magnesia added with constant stirring. Give in nine glass doses. Good for arsenic, zinc, opium, digitalis, mercury and strychnine. Not good for phosphorus, alkalies, or antimony.

Physiological antidotes. Another class of antidotes is termed "physiological antidotes." These antidotes merely mask the symptoms produced. Used against absorbed poisons they tend to combat the symptoms by arousing an opposite action. They very often carry the patient over the critical period and aid in preserving life. Following are some examples:

Atropine to morphine
Atropine to pilocarpine
Barbiturates to cocaine
Caffeine to morphine
Chloroform to strychnine

The use of physiological antidotes is strictly limited to the physician alone.

Antidote kit. The following materials has been suggested by Sollmann to meet poison emergencies. The kit is suggested **for use by the physician** with each container having the dose carefully written on the label.

Amyl nitrite pearls
Apomorphine tablets (2 mg.)
Atropine tablets (1 mg.)
Caffeine-sodium benzoate
Powdered animal charcoal
Chloroform
Cocaine hydrochloride tablets (0.03 gm.)
Epinephrine tablets (1 mg.)
Tincture iodine (7%)
Cupric sulfate (powdered)
Limewater
Magnesia (calcined)
Morphine sulfate tablets (10 mg.)
Olive oil
Potassium permanganate (1% aq. sol.) (to be diluted 20 times)
Sodium sulfate
Aromatic spirits of ammonia
Strychnine sulfate tablets (2 mg.)
Whiskey
Hypodermic syringe
Stomach tube
Funnel

The following can be secured at the site where the poisoning occured: boiled water; hot, strong, black coffee; eggs; heat applications such as water bottles, etc.; milk; mustard; salt; soap; starch; tea; vinegar.

Demulcents have a soothing effect on inflamed membranes. They are usually given after most of the poison has been removed or counteracted. The following demulcents are suggested:

Milk
Whites of eggs
Flour paste
Flaxseed tea
Elm bark tea
Gelatin solution
Gum Arabic solution
Oatmeal gruel
Cream of Wheat

If the stomach tissues are injured, cool the demulcents before feeding.

Special Treatments

Cathartics induce bowel movement. **If abdominal pains are present cathartics should not be used because the pains may be caused by appendicitis.** Cathartics, however, are seldom used,

since the poison is best brought out by way of the mouth. If the poison has been swallowed several hours before first aid is administered, or if the poison is quickly absorbed, the physician may recommend the use of cathartics. (Laxatives, milk of magnesia, mineral oil, and agar-agar are often used.)

The form in which the poison is eventually eliminated varies considerably. For example wood alcohol is excreted as formic acid within a few days; on the other hand ethyl alcohol is oxidized and eliminated from the body as carbon dioxide and water within 24 hours. Mercury bichloride is taken up by the white blood cells, chiefly in the liver and kidneys, and appears in the urine and feces within a few hours to two weeks after ingestion. Carbon monoxide remains in the blood and muscles for several hours.

Stimulants increase the activity of the heart and the nervous system. **Care should be exercised that stimulants are not given to persons sustaining head injuries, internal injuries, or excessive bleeding. Alcoholic beverages are not good stimulants.** For some poisons there are certain stimulants that should be carefully avoided, for they produce bad effects; these cases are noted under each poison in the next chapter. Otherwise generally useful stimulants are:

Aromatic spirits of ammonia (1 teaspoonful in ½ glass of water)
Strong, hot, sweetened coffee or tea

Analgesics and sedatives are preparations that induce sleep and relieve pain. **Unless prescribed by a physician, analgesics and sedatives should be avoided,** as many of these preparations are habit-forming. Aspirin tablets (5 grain) are helpful, and are not considered habit-forming.

Chapter 3

Special Properties of Poisons

GENERAL INFORMATION. CHEMICAL IDENTIFICATION. SYMPTOMS. EMERGENCY TREATMENTS.

Because this book is intended for use during an emergency, it is desirable to give specific and practical information about individual poisons. A similar pattern is followed in characterizing and describing each poison. The pattern follows four main topics:

1. General information covering in the order mentioned: name, formula, other names for the same substance, physical appearance, industrial preparation and use, medical use; normal medicinal dose, and fatal dose. The most common name is given first. Acids and alcohols are listed under A, that is Acid, Hydrochloric; Acid, Sulfuric; Alcohol, Ethyl; Alcohol, Methyl. Refer to the index at the back of this book if you do not immediately locate the name of the poison you suspect. Fluorides, for example will be found both under Acid, Hydrofluoric and Sodium Fluoride.
2. Identification by chemical means.
3. Symptoms: identification by physiological means.
4. Emergency treatment: first aid before the physician arrives.

ACETANILID ($C_6H_5NHCOCH_3$), acetylaminobenzene, acetylaniline, antifebrin, or phenylacetamide is colorless, odorless, crystalline scales or powder, with a slightly pungent taste. It is produced by boiling aniline with glacial acetic acid for several hours; the crystalline mass resulting from this process is then distilled. It is used in manufacturing medicinals and dyes, in stabilizing hydrogen peroxide, and in varnishes.

Acetanilid is used principally to relieve neuralgic and muscular pains, or to reduce temperature in mild fevers; also as a dry powder, with or without boric acid, for antiseptic dressings.

Most poisonings from acetanilid are accidental. Average dose is 3 grains, or 0.2 grams; fatal dose is difficult to determine, but 10 to 20 grains may kill a person with a weak heart, whereas a person with a normal heart may survive a dose up to 30 grains. Death may be sudden or the victim may linger for several days.

Identification. Para-aminophenol is found in the urine the morning after repeated doses of acetanilid have been taken. Extracted with ether. *Test 1.* (a) Conc. HCl; (b) fresh aq. solution of chloride of lime; (c) aq. potassium permanganate; (d) aq. 5% sodium nitrate; (e) dil. sodium hydroxide; (f) 5% beta-naphthol in ethyl alcohol. Treat unknown with (a), then dilute with water. Separate into three portions, and test as follows. Portion 1: Let 1 cc. of (b) run gently down side of tube. Blue color at Juncture = acetanilid. Portion 2: Add 1 cc. (c). Green = acetanilid. Portion 3: Add few drops (d); make alkaline to litmus paper with (e), and then add a few drops (f). Red basic azo dye = acetanilid. (See **Phenacetin** tests.) *Test 2.* (g) Chloroform; (h) dil. potassium hydroxide. Gently heat 2 cc. unknown + 2 cc. (g) + 2 cc. (h). Offensive odor of phenylisocyanide = acetanilid and other aniline derivatives.

Symptoms. Nausea and vomiting; cyanosis (face and hands blue); slow, feeble pulse; subnormal temperature; mental sluggishness; stupor; collapse.

Treatment. Summon a physician. Wash out the stomach with an emetic of Epsom salts, administer oxygen to relieve the cyanosis, and apply artificial respiration if necessary. Keep the patient warm, quiet, and in a recumbent position.

Other Poisons. Acetophenetidin, aminopyrine, aniline dyes and inks, antipyrine, and phenacetin same treatment as for acetanilid.

ACID, ACETIC (CH_3COOH) is a colorless, pungent organic acid, 100,000 tons of which are manufactured each year by catalytically adding water to acetylene to form acetaldehyde, followed by

oxidation with air. A second method is the distillation of wood, a crude acetic acid known as pyroligneous acid being produced; this is one source of acetic anhydride, from which acetate plastics, airplane dopes, cellulose acetate rayon, moving picture safety film, etc. are made in enormous tonnages. Acetic acid is also widely used in rubber coagulation, in the textile dyeing and printing trades, for gums and resins, as a solvent for many organic compounds, and in the manufacture of acetate chemicals.

A solution containing about 99.5% (over 99%) acetic acid in water is called **glacial acetic acid** because it freezes to an icelike or glacierlike solid just below room temperature. This concentrated acid is used by some physicians to destroy warts. Glacial acetic acid causes severe burns upon contact with the skin.

A *very dilute* solution (6% acetic acid) is used by some physicians as a cooling drink to relieve thirst from fever, or in fever-cooling lotions.

By law, vinegar, which is made by the fermentation of cider, must contain over 4 grams of acetic acid per 100 grams of vinegar (actual content varies between 4% and 5%). Since acetic acid is a weak acid, and since vinegar is only a dilute solution of this weak acid, ordinary household vinegar is a most useful acid for neutralizing alkalies that have been accidentally swallowed. (See page 10).

Average dose of the 6% solution is 30 minims, or 2 cc. Two tablespoonfuls of glacial acetic acid has caused death of an adult. Death occurs in a few hours.

Identification. Odor of vinegar identifies acetic acid.

Symptoms. Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles, or convulsions; collapse.

Treatment. Summon a physician. If concentrated acids have been swallowed, avoid the use of emetics, stomach pump, or carbonates (that is, avoid chalk, whiting, or baking soda); the carbonates react with the acid to give a violent evolution of carbon dioxide gas, which may further damage the injured stomach tissue. Neutralize

the acid with an alkali such as limewater, milk of magnesia, or soapsuds. However, if dilute acid has been swallowed, chalk or bicarbonates may be used. Have the victim swallow plenty of water to help dilute the acid. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep patient warm and quiet.

External Treatment. Wash with an abundance of water, and apply a paste made with water and baking soda, or water and chalk; finally wash off again with quantities of water.

ACID, BORIC, or **BORACIC ACID,** commonly refers to **ORTHOBORIC ACID** (H_3BO_3), which has been obtained for a hundred years by condensation and crystallization of hot gases from volcanoes in Italy. The acid is obtained also by treating borax ($Na_2B_4O_7 \cdot 10H_2O$) with hydrochloric acid. Boric acid forms white, thin, lustrous flakes. Borax, of great importance in making Pyrex brand glass, is a familiar cleaner and water softener about the home.

Externally boric acid is used in ointments and dressings for burns, cuts, and skin diseases; in a 1 to 4% solution as an eye wash; and in a 2 to 4% solution as an irrigant. The chief danger is in mistaking boric acid for sugar, in making up an infant's milk formula. One to 2 grams per day may result in serious symptoms.

Identification. Borates are found in the urine. (a) Aq. $NaNO_3$; (b) aq. Na_2CO_3; (c) ethyl alcohol. Evaporate urine to near dryness; then add 1 cc. (a) + 1 cc. (b). Heat to dryness. Mix residue with 2 cc. (c) and burn. Green flame = boron as volatile $(C_2H_5)_3BO_3$.

Symptoms. Nausea, vomiting, diarrhea, headache, cold sweat, subnormal temperature, rash, weak heart, collapse.

Treatment. Eliminate its use. If the poisoning is acute, summon a physician. Wash out the stomach with an emetic, give hot coffee or milk as a stimulant. Avoid baking soda. Keep the patient warm and quiet.

ACID, CAMPHORIC. (See Camphor.)

ACID, CARBOLIC (see **Phenol**). This is not really an acid; the name is misleading. It should not receive the general first-aid treatments given for acids.

ACID, HYDROCHLORIC (HCl), chlorhydric acid, muriatic acid, or spirit of salt is sold chiefly as an aqueous solution containing about 38% HCl. This solution has a pungent odor, fumes; it gives off white smoke if a bottle of ammonium hydroxide is brought near. The pure acid is colorless, but the commercial product is often yellowish from traces of iron salts. Hydrochloric acid is produced commercially either by the combination of hydrogen and chlorine, or by the action of sulfuric acid on common table salt (sodium chloride). The acid is used extensively in the laboratory, in industry to clean metals such as in preparing a surface for soldering or plating, and to prepare soluble salts, such as morphine hydrochloride.

Dilute hydrochloric acid is prescribed by some physicians for internal use to control stomach acidity and to stimulate digestion; in pernicious anemia; and to allay thirst from fever. Externally the acid is a mild astringent in eczema and skin irritations.

Hydrochloric acid is one of the strongest known acids, comparable to nitric acid in chemical action. Most of the poisoning cases from this acid are accidental. A few drops of concentrated acid entering the windpipe may produce death rapidly. Fifteen cc. is considered sufficient to cause death when taken directly into the stomach.

Identification. Turns blue litmus paper pink. *Test 1.* (a) Dil. NH_4OH. Open bottle of (a) brought near unknown. White smoke fumes of NH_4Cl = hydrochloric acid. *Test 2.* Use unknown diluted with water. (b) Aq. silver nitrate; (c) dil. HNO_3. One cc. of aq. unknown + 1 cc. (b) + 1 cc. (c). White precipitate, turns slightly purplish in sunlight = hydrochloric acid or a chloride as AgCl.

Symptoms. Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles, or convulsions; collapse.

Treatment. Summon a physician. Avoid emetics, stomach pump, or use of chalk, whiting, or other carbonates if concentrated acid has been swallowed; these may all injure the damaged tissues.

Neutralize the acid with an alkali such as limewater, soapsuds, or milk of magnesia. Give plenty of water to help dilute the acid. Feed raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep patient quiet and warm.

External Treatment. Wash with abundance of water and apply a paste made with water and baking soda.

ACID, HYDROCYANIC (HCN) or prussic acid occurs in aqueous solution. Pure hydrogen cyanide is a colorless, inflammable liquid, which boils near room temperature (79° F.). Both the liquid and the aqueous solution have the odor of bitter almonds. The solution, which is a weak acid, is manufactured by distilling a concentrated solution of sodium or potassium cyanide with dilute sulfuric acid, and absorbing the vapors in water. The gas may be compressed as pure, liquid hydrogen cyanide containing as warning gases 5 to 10% lachrymators such as chloropicrin, or 20% cyanogen chloride. These are used as fumigants to rid ships and warehouses of rodents and vermin and to fumigate citrus trees. It is not a germicide or bactericide. Cyanide salts are also used in insecticides, for case-hardening steel, and in electroplating solutions.

Hydrocyanic acid is one of the most poisonous substances known; the inhalation of its fumes in high concentration will cause almost immediate death. Hydrogen cyanide acts by preventing the normal processes of oxidation in the respiratory center in the brain. Most of the accidental cases are due to inhaling the fumes during a fumigating process. In the pure state it kills with lightning rapidity. Crystalline cyanides, such as sodium or potassium cyanide, are equally poisonous, since they interact with the hydrochloric acid in the stomach to liberate hydrocyanic acid. This poison has been used both for homicidal as well as suicidal purposes; during the past century Europeans were known to carry vials of cyanide salt for emergency self-destruction. Deaths resulted from amounts of only a fraction of a gram. A concentration of 1 part in 500 (2.5 mg. per liter) of hydrogen cyanide gas is fatal. Allowable working con-

centration in New Jersey and Massachusetts is 20 ppm. Two and one half grains of liquid acid has killed. The acid acts fatally in about 15 minutes. The cyanide salts kill in several hours. Average dose of the 2% solution is 1.5 minim or 0.1 cc.

Identification. Cyanides produce an odor of oil of bitter almonds on the breath or in vomitus. *Test 1.* (a) Aq. mercuric chloride solution; (b) 2.5% aq. methyl orange; (c) glycerine. Dip filter paper into mixture containing 20 cc. (a) + 10 cc. (b) + 2 cc. (c). Dry paper will keep a month in airtight, amber vials. Paper held to mouth will turn pink in 2 minutes (Sherrard reagent). *Test 2.* (d) Aq. 3% cupric acetate; (e) glacial acetic acid saturated with benzidine (filter by suction). Immediately before using mix 15 cc. water + 1 cc. (d) + 5 cc. (e); dip in filter paper; hold wet paper to breath or dip in vomitus. Blue color in 7 to 10 seconds = 20 to 80 mg. hydrogen cyanide per cubic meter.

Symptoms. Since this is an extremely rapid poison, rapid action is necessary. Occasionally the victim may make a few voluntary actions before death results or alarming symptoms set in. Death results from paralysis of the respiration. When a smaller dose is taken the symptoms are: dizziness, headache, shortness of breath, followed by convulsions, coma, and collapse.

Treatment. Summon a physician. Immediate treatment is necessary to be of value. If amyl nitrite is available, have victim inhale immediately for 20 seconds. Have victim swallow 2 tablespoonfuls of hydrogen peroxide (3% household variety). Wash out the stomach with hydrogen peroxide. Have victim inhale ammonia. Administer oxygen, and apply artificial respiration immediately.

Other Poisons. Bitter almond oil, cherry laurel water, and other cyanides same symptoms and treatment as for **Hydrocyanic Acid.**

ACID, HYDROFLUORIC $(HF)_6$, fluohydric acid, or hydrogen fluoride occurs mostly as an aqueous solution of the colorless, odorless gas (liquefies at 68° F.). The solution is obtained by treating powdered calcium fluoride with concentrated sulfuric acid, distilling in a retort of lead or platinum, and absorbing the vapor of hydrogen fluoride in water. The acid is stored in wax, guttapercha,

rubber, lead or plastic containers, since glass bottles are etched by this extremely corrosive solution. The concentrated acid will fume. The pure liquid, the vapor, and the aqueous solutions are all employed commercially for etching enamelware and glass, for frosting lamp bulbs, in the manufacture of fluorides, for removing sand from metallic castings, and in the laboratory for analysis of silicate rocks. The use of hydrofluoric acid in industry is increasing.

Hydrogen fluoride, as vapor, liquid, or solution, is violently corrosive and extremely dangerous, causing painful skin sores. Most of the poison cases from it are accidental. Two drams has caused death of an adult. A vapor concentration of 3 ppm. is the maximum concentration for workers in Massachusetts and New Jersey.

Identification. Hydrofluoric acid or sodium fluoride may be identified by placing the amount to be tested in a shallow container, adding a little concentrated sulfuric acid, and covering the container with a piece of glass (watch crystal). The glass will etch when heat is applied to the container.

Symptoms. Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles; convulsions; collapse.

Treatment. Summon a physician. If much acid has been swallowed avoid emetics, or carbonates (avoid chalk, whiting, baking soda). Instead, give plenty of water to help dilute the acid. Neutralize the acid with an alkali such as limewater, milk of magnesia, or soapsuds. The stomach may be washed out by a physician but care should be exercised, as the stomach tube may penetrate the weakened wall of the stomach. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient warm and quiet.

External Treatment. Wash thoroughly with soap and water; and apply a paste of sodium bicarbonate, or chalk and water, or milk of magnesia.

Other Poisons. Roach powders or other fluorides same symptoms and treatment as for **Sodium Fluoride** (see later).

ACID, NITRIC (HNO_3), aqua fortis, or azotic acid is a heavy, dangerous, corrosive liquid. Commercial concentrated acid contains about 68% HNO_3, and is colorless if pure, but is often yellow from nitrogen dioxide, which forms in it on exposure to air and light. The acid is prepared industrially by the catalytic oxidation of ammonia; a small quantity is still prepared by the older process of treating Chile saltpeter ($NaNO_3$) with concentrated sulfuric acid.

An especially corrosive variety, **fuming nitric acid,** contains 87 to 92% HNO_3, and is deep reddish-yellow from excess nitrogen dioxide dissolved in it; even the reddish-brown fumes from it instantly attack the human tissue.

Nitric acid is a powerful oxidizing agent. With cotton or wood it forms cellulose nitrates, the basis of some nitrate explosives (guncotton, nitroglycerin, smokeless powders), and of nitrate plastics (celluloid, pyroxylin film, and lacquers). It also forms nitroexplosives such as picric acid (trinitrophenol) and T.N.T. (trinitrotoluene). Nitric acid is used in producing organic nitrogen compounds, and in the etching, photoengraving, and paper trades. Enormous tonnages go into producing nitrate fertilizers.

Certain concentrations are used externally for warts, snake bites, ulcers, etc. Human tissue and wool form a deep yellow compound even with the dilute acid. Three fluid drams of the concentrated acid is considered a dose fatal to adults.

Identification. Litmus turns pink; paper may be destroyed with conc. acid. Fingers and clothing stained distinctly yellow on contact with acid. (a) Copper alloy, such as a penny or a dime. Heat unknown with (a); brown fumes (NO_2) = nitric acid.

Symptoms. Burns, yellowish in color, appearing on the lips and mouth; severe pains in the throat and stomach; nausea and vomiting; thirst; difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles; convulsions; collapse.

Treatment. Summon a physician. Avoid emetics, stomach pump, or carbonates (avoid chalk, whiting, baking soda) if concentrated acid has been swallowed. Have the victim swallow plenty of water to help dilute the acid. Neutralize the acid with an alkali such as milk

of magnesia, limewater, soapsuds, etc. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep patient warm and quiet.

External Treatment. Wash with abundance of water and apply a paste made with water and baking soda.

ACID, OXALIC ($H_2C_2O_4 \cdot 2H_2O$) or acid of sugar (the latter name because at one time it was manufactured from sugar or sawdust) is today produced by the action of carbon monoxide on sodium hydroxide. The pure colorless crystals it forms are so stable that they are used as an oxidation-reduction standard in analytical chemistry. Oxalic acid has a bitter taste, which makes it easy to detect. Industrially it is used to bleach textiles, straw hats, leather, and furniture; also in ink and rust eradicators, and in metal polishes.

In medicine its chief use today is to react with, and remove, the permanganate wash from surgeon's gloves. Dentists use a 10% solution of oxalic acid to hasten the hardening of plaster of Paris impressions.

Persons have often accidentally swallowed oxalic acid thinking it was Epsom salts, because the two substances resemble each other in appearance. Owing to rapid absorption of oxalic acid, death is likely to occur within an hour, but it may be delayed for several hours. The lethal amount varies between 1 and 3 drams. Usually ½ to 1 ounce produces death. When the dose is too large, vomiting occurs, which offers relief, and possible recovery.

Identification. *Test 1.* (a) Dil. H_2SO_4; (b) aq. potassium permanganate diluted to faint pink; (c) aq. manganous chloride. To 5 cc. of unknown solution add 1 cc. (a) + 10 cc. (b) + a few drops (c) (catalyst). Solution becomes colorless if heated to just below boiling (tube uncomfortably hot to hold) for 5 minutes = oxalates. *Test 2.* (d) Aq. $CaCl_2$. Unknown solution + few drops (d). White precipitate of calcium oxalate = oxalates.

Symptoms. Severe pains in the throat and stomach, nausea and vomiting; intense thirst; rapid, weak pulse; slow, shallow breathing; twitching of the muscles; convulsions; collapse.

Treatment. Summon a physician. Avoid baking soda, alkali carbonates, alkalies. Oxalic acid does not destroy stomach tissues as do nitric acid and other strong acids; instead it poisons the blood-stream. Therefore, as soon as the patient has been given plenty of water to dilute the acid, and milk of magnesia to neutralize the acid, give an emetic of mustard in warm water to get the acid out of the stomach. Give stimulant of black coffee or whiskey if necessary. Use raw eggs and milk to protect the membranes of the esophagus and stomach. Keep the patient warm, quiet, and in a recumbent position.

External Treatment. Wash with an abundance of soap and water, and apply a paste made with water and baking soda for any redness or burns of the skin.

Other Poisons. Oxalates; same treatment as for **Oxalic Acid.** See **Potassium Binoxalate** (salt of sorrel or salt of lemon).

ACID, PHOSPHORIC (H_3PO_4) commonly indicates orthophosphoric acid, which is sold as a colorless, syrupy water solution, containing 85% H_3PO_4 in water. It is made by burning phosphorus and dissolving the oxide in hot water, or by adding sulfuric acid to either bone ash or to phosphate rock. Phosphoric acid is rapidly increasing in importance as an industrial acid; it is used also to produce phosphates, as a substitute for organic acids in foods and soft drinks, as a rust preventive, in engraving, in dental cements, to coagulate rubber, and in chemical analysis.

A weak solution is sometimes prescribed by physicians to relieve thirst from fever, and in stomach disorders.

Average dose of the solution is 15 minims, or 1 cc. Slightly less than 2 drams has caused death of an adult.

Identification. (a) Aq. silver nitrate; (b) dil. HNO_3. To aq. unknown add 1 cc. (a) + 1 cc. (b) . Yellow precipitate of Ag_3PO_4 = orthophosphates. Boil the original solution for 2 minutes and repeat test. White precipitate of $Ag_4P_2O_7$ or $AgPO_3$ = phosphates.

Symptoms. Burns on the lips and mouth; severe pain in the throat and stomach; nausea and vomiting; intense thirst; difficulty in

swallowing; rapid, weak pulse; slow, shallow breathing; twitching of the muscles, or convulsions; collapse.

Treatment. Summon a physician. Avoid stomach tube, emetic, or carbonates, if the acid taken was in concentrated form. Give plenty of water to help dilute the acid. Neutralize the acid with lime-water, or milk of magnesia. Give raw eggs and milk to protect the mucous membranes of the esophagus and stomach. Keep the patient warm and quiet.

External Treatment. Wash with abundance of water, and apply a paste made with water and baking soda, or water and chalk.

ACID, SULFURIC (H_2SO_4), vitriol, or oil of vitriol is a heavy, oily liquid, powerfully corrosive. It is manufactured by catalytically combining sulfur dioxide with oxygen to form sulfur trioxide; the latter with water forms sulfuric acid. Ordinary concentrated sulfuric acid contains about 98% H_2SO_4, and does not fume; a still more concentrated variety known as **fuming sulfuric acid,** Nordhausen acid, or oleum, containing up to 80% free SO_3, is used extensively in the dyeing industry. Both varieties have an enormous affinity for water, and will char wood, paper, or the human body; although in the latter case charring may be only on the surface tissue if the acid has been immediately flushed off with water. A dangerous amount of heat is given off when water and concentrated sulfuric acid are mixed; always pour the acid *into* a very large amount of water, while stirring.

Sulfuric acid has been called "the yardstick of civilization" because, as perhaps our most important acid, it is used in nearly every chemical industry: textile, rubber, paper, petroleum, explosives, electroplating, etc.

Elixir of vitriol is a mixture containing 19 to 21% sulfuric acid with alcohol, cinnamon, and ginger; the mixture finds a place in dentistry as protection against pyorrhea or decaying tissues. A 10% solution of sulfuric acid at one time was used to allay fever, in diarrhea, and in treating lead poisoning, etc.

Because of its tremendous corrosive action sulfuric acid is not usually given for homicidal purposes except to children. It is some-

times thrown on a person to disfigure him, and may cause death from the severe burns inflicted on the skin. Most of the cases of poisoning from this acid result from accidents. Death of an adult has been caused by 3.8 grams; and 20 drops may be fatal to a child.

Identification. Dilute sulfuric acid turns litmus pink; may stain clothing red. Concentrated sulfuric acid chars wood, paper, and sugar; burns brown holes in clothing. *Test 1.* (a) Make a dilute solution of unknown **(Care! Add cautiously in order indicated, while stirring; keep face away, much heat evolved)** by adding 1 cc. of unknown to 10 cc. of water; (b) aq. barium chloride; (c) dil. HNO_3. One cc. unknown solution + 1 cc. (b) + 1 cc. (c). White precipitate of $BaSO_4$ = sulfuric acid or sulfates.

Symptoms. Burns on the lips and mouth which are first whitish and later turn brown; severe pains in the throat and stomach, nausea and vomiting, intense thirst, difficulty in swallowing; rapid, weak pulse; slow, shallow breathing; convulsions and collapse.

Treatment. Summon a physician. Avoid stomach tube, emetics, or carbonates (whiting, chalk, baking soda) if the acid taken was in concentrated form. Give plenty of water to help dilute the acid; then neutralize the acid with limewater, milk of magnesia, soapsuds, etc. Protect the mucous membranes of the esophagus and stomach by giving raw eggs and milk. Keep the patient warm and quiet.

External Treatment. Wash with abundance of water and apply a paste made with water and baking soda.

ACONITE—friar's cowl, monkshood, mouse bane, or wolf's bane is obtained from the dried tuberous root of the *Aconitum napellus,* a source of alkaloids, and one of the deadliest drugs. It was used even by the ancients, who prohibited traffic in it, under penalty of death. **ACONITINE** ($C_{34}H_{49}O_{11}N$), the active principle of the plant, is a bitter, white, crystalline powder.

At one time aconite was used internally to slow the pulse and to reduce fever; today its value is doubted. External use in neuralgia is also finding less favor, because of danger from absorption through the skin, and subsequent poisoning. If the aconite has been applied to a break in the skin tissue, poisoning from absorption is extremely

likely. Also the investigator should distinguish between crystalline aconitine and amorphous aconitine; the crystalline variety is 10 to 15 times more poisonous than amorphous aconitine, and a mistaken dosage is possible. The majority of poisoning cases result from accidents. The symptoms come on rapidly; death from the pure alkaloid may occur suddenly; and death from the tincture usually takes place in 3 or 4 hours. Death has resulted in 8 minutes. The fatal dose is uncertain, probably slightly over 1 mg.

Identification. (a) Syrupy phosphoric acid; (b) sodium molybdate solution. Unknown + few drops (a) + (b); heat over flame. Violet color = aconite. (c) Dil. H_2SO_4. Unknown + (c). Yellow to brown to violet = aconite.

Symptoms. An overdose causes salivation; a tingling sensation on the lips, mouth, and in the throat; nausea and vomiting; diarrhea; slow, weak pulse; collapse.

Treatment. Summon a physician immediately. Since the poison acts rapidly, the treatment must be prompt. Avoid emetics, since unless they can be given immediately they fail, and only cause the patient to exhaust himself. Give powdered charcoal. Give 4 grains of potassium permanganate in water. Keep the patient warm, quiet, and in a horizontal position with head low; cold to head, heat to body. Give a heart stimulant such as aromatic spirits of ammonia (1 teaspoonful in ½ glass of water) if necessary.

Other Poisons. Delphinine, larkspur, and veratrine same treatment as for **Aconite.**

ALCOHOLS are organic compounds containing the hydroxyl (OH) radical. They are of tremendous importance in chemical industry as solvents. The three alcohols most likely to be encountered are (1) *methyl* or *wood alcohol,* which causes blindness, followed by death; (2) *ethyl* or *grain alcohol,* which is a component of ordinary alcoholic beverages; and (3) *isopropyl alcohol,* which has appeared recently as a rubbing alcohol. See below for individual treatments. Fusel oil is a mixture of amyl alcohols ($C_5H_{11}OH$) produced in the

fermentation of corn and other grains. They are bad-smelling liquids, which cause tears, coughing, headache, and dizziness.

ALCOHOL, ETHYL (C_2H_5OH), ethanol, ethyl hydroxide, grain alcohol, rectified spirit, spirit of wine, or vinous alcohol is an inflammable, clear, colorless liquid having a characteristic pleasant odor and burning taste. It is produced by fermenting sugars as in molasses, or starches as in grains and potatoes. The fermenting materials are organic catalysts, called enzymes, which occur in yeast, a vegetable compound. Ethyl alcohol is also produced from the hydrocarbon gases acetylene and ethylene. Ethyl alcohol is used extensively as a solvent in perfumes, flavorings, extracts, and tinctures; in plastics, antiseptics, gums, resins, shellacs, etc. It is a motor fuel in certain countries (e.g. India) where gasoline is scarce.

The common term "alcohol" generally means a water solution containing 95% ethyl alcohol, which is easily obtained by distillation. But if special drying agents are used the last 5% of water is removed to form anhydrous or absolute alcohol. **Denatured alcohol** is ethyl alcohol to which camphor, benzene, pyridine bases, etc. are added to make it unfit as a beverage, while retaining its usefulness in other respects.

In beverages, ethyl alcohol content is classified on the proof-gallon, which is 50% water. According to this classification whiskey, rum, brandy, and gin are slightly under 100-proof (50% alcohol), wines are 20 to 40 proof (10 to 20% alcohol), and beers are 4 to 12 proof (2 to 6% alcohol).

Internally, ethyl alcohol is used as a stimulant (whiskey, brandy), a hypnotic, a narcotic; and to settle the stomach. Externally it is used to sterilize the skin of patient and surgeon; and its cooling effect upon evaporation makes it useful as a lotion for bruises, inflammations, and headaches.

Deaths from this alcohol are usually the results of excessive drinking, although fatal results have occurred from even 1 pint of whiskey. Two and one half ounces has proved fatal to a child.

Identification. *Test 1.* (a) Aq. NaOH; (b) tincture of iodine. To 2 cc. unknown liquid add a few drops (a); then drop by drop add (b) in excess (until color is permanent straw yellow). Character-

istic iodoform odor or crystals (may have to heat one minute, then cool) = ethyl alcohol, acetone, or some other organic substances; but iodoform is not given by methyl alcohol. *Test 2.* (c) copper wire. Heat unknown liquid in tube; plunge red-hot copper spiral into liquid. Sharp odor of formaldehyde = methyl alcohol. Sweeter odor of acetaldehyde = ethyl alcohol present in original unknown.

Symptoms. Effects vary in individuals: some become quarrelsome, others sentimental, while still others fall asleep and have no stage of excitement at all. When large amounts are taken, nausea and vomiting occur, and the patient enters a depression stage.

Treatment. Summon a physician. The stomach should be washed out with an emetic. Apply cold applications to the head, give stimulants of hot coffee or tea, keep the patient warm and quiet.

ALCOHOL, ISOPROPYL [$(CH_3)_2CHOH$], dimethylcarbinol, isopropanol, or secondary propyl alcohol is a colorless liquid with an acetone-like odor. The alcohol is manufactured as an oxidation product of petroleum, and appeared in 1940 as a substitute for denatured, rubbing alcohol, the latter being an important military chemical.

Identification. Isopropyl alcohol has an odor somewhat resembling acetone. (a) Mercuric sulfate solution (to make, stir 2 g. yellow mercuric oxide with 16 cc. water; then add 8 cc. conc. H_2SO_4 and continue stirring; finally add 16 cc. more water and stir until completely dissolved). Mix 1 cc. unknown liquid with 5 cc. (a); heat very gently (steam bath) for 5 minutes. Precipitate shows original was isopropyl alcohol, acetone, or other ketones.

Symptoms. Not a great deal is known about the poisonous characteristics of isopropyl alcohol, but its characteristically unpleasant odor serves to warn against its use in beverages. It is more likely to cause nausea and vomiting than to poison dangerously.

Treatment. Same as for **Ethyl Alcohol.**

ALCOHOL, METHYL (CH_3OH), Hasting's naphtha, methanol, pyro alcohol, pyroligneous spirit, wood alcohol, or wood naphtha is a clear, colorless liquid, possessing a winelike characteris-

tic odor, and a burning taste. Previous to 1924 it was obtained by the distillation of wood, from which the name wood alcohol was derived; but today it is manufactured catalytically by adding hydrogen to water gas. Industrially it is important as a solvent for shellacs and resins, as an antifreeze for automobiles, as a motor fuel, and in the manufacture of many organic chemicals.

Methyl alcohol is toxic in small doses, even if inhaled; and in the concentrated form affects the optic nerve, causing blindness. The fatal dose varies between 1 and 2 ounces. It has been stated that 4 ounces of wood alcohol drunk by each of ten persons would produce pain in the abdomen in all within 3 hours; four would die, two of these would be blind before death, six would recover, but of these six, two would be permanently blind. A concentration of 200 ppm. of vapor is allowable for workers in New Jersey and Massachusetts.

Identification. See tests under **Alcohol, Ethyl.**

Symptoms. The beginning symptoms are similar to those caused by grain alcohol: exhilaration and excitement, followed by nausea and vomiting, dizziness, headache, dilated pupils and delirium. Persevering coma and death may follow within hours or a few days. The victim may recover from the acute symptoms but blindness may result from the destruction of the optic nerve.

Treatment. Summon a physician. The stomach should be washed out with an emetic and large quantities of water. Keep the patient warm and quiet.

AMMONIUM HYDROXIDE (NH_4OH), ammonia water, aqua ammonia, or spirits of hartshorn is formed when ammonia gas, NH_3, is dissolved in water; the concentrated commercial solution contains 28 to 29% NH_3. It has a pungent, suffocating odor, an acrid taste, and is clear and colorless. Ammonium hydroxide is used in cleaning, in removing stains and dirt, in bleaching calico, in extracting plant dyes, in manufacturing ammonium compounds, and for a wide variety of uses around the home. Liquid ammonia is used as a refrigerant liquid in some artificial skating rinks and commercial refrigerating units.

HARTSHORN SALT, a smelling salt, is a mixture of ammonium carbonate and carbamate. Household ammonia may be clear or cloudy; in the latter case ammonium carbonate has been added to improve the product.

AMMONIA WATER U.S.P.XI, a 10% aqueous solution, is used by some physicians internally as aromatic spirits to prevent fainting. The external use of sniffing the vapor to revive persons who have fainted is well known; it is also a convenient wash to neutralize the acid in bee and insect stings.

AMMONIUM HYDROXIDE is a powerfully corrosive poison, and inhaling much fumes gives rise to bronchopneumonia. Ammonium hydroxide has often been taken accidentally, and in some cases as a means of homicide or suicide.

AMMONIA FUMES in concentrations of 0.5 to 1.0% by volume are lethal to man in a few minutes. A teaspoonful of concentrated ammonium hydroxide has caused death; on the other hand recovery has followed the taking of a fluid ounce.

Identification. Turns litmus blue. Odor in breath and vomitus. (a) Conc. HCl. Bring open bottle of (a) near unknown. White fumes of NH_4Cl = ammonium hydroxide.

Symptoms. If strong ammonia fumes are inhaled they cause the larynx to swell; this may cause asphyxia. When the solution is swallowed, extensive destruction is done to the mucous membranes of the esophagus. Large quantities cause convulsions and collapse in addition to the always present nausea and vomiting, pain in the throat and stomach, and cold, clammy skin.

Treatment. Here, as in all poisoning cases, it is very important that the physician be summoned at once. Avoid emetics or stomach tube. Neutralize the alkali at once with an abundance of vinegar, lemon juice, or other weak acid juices. Follow with raw eggs, cream, or olive oil to protect the membranes. Administer oxygen or artificial respiration if necessary. Keep the patient warm and quiet.

External Treatment. Wash thoroughly with water, then with lemon juice, vinegar, and again with water. If the ammonium hy-

droxide has gotten into the eyes, wash with a 5% solution of boric acid.

ANTIMONY (Sb) stibium, or regulus of antimony is a silvery white, lustrous, hard, brittle metal, which occurs naturally as the sulfide, Sb_2S_3, called stibnite. As a metal it is tasteless, odorless, and nontoxic. Heated, it volatilizes in air, forming antimony oxides. The compounds of antimony are toxic. **Antimony trichloride,** a liquid, and antimony potassium tartrate (**tartar emetic**) are the two compounds usually encountered in poisoning cases. Antimony and its compounds are used in medicine, in alloys, in fireworks, as a bronzing liquid, to blacken iron, etc. Salts of this metal have been responsible for cases of homicide, suicide, and accident. A fatal dose may cause death in from a few hours to a few days. Since the compounds of antimony produce vomiting, the exact fatal dose is uncertain. One and one half grains has caused death of an adult; and ¾ of a grain has proved fatal to a child.

Identification. See **Arsenic** tests for necessity and method of removing organic matter. See page 16, spot tests. Orange sulfide, Sb_2S_3, is characteristic.

Symptoms. The victim has a metallic taste, pains in the epigastric, shock symptoms, vomiting of blood-stained material; spasms of the fingers, arms, and legs; collapse.

Treatment. Summon a physician. Give about 20 grains of tannic acid at once in a cupful of warm water, and repeat in 5-grain doses every 30 minutes. If this is not available give strong tea. Empty stomach with emetic, give large quantities of warm water followed by raw eggs or milk. Keep the victim warm and quiet.

ANTIPYRINE ($C_{11}H_{12}ON_2$), analgesine, anodynine, dimethyl-oxy-quinizine, oxydimethyl-quinizine, parodyne, phenazone, phenylone, 1-phenyl-2, 3, -dimethyl pyrazolon, pyrazoline, or sedatine is colorless, odorless powder or tabular crystals. Its uses, symptoms and treatment are similar to those for **Acetanilid.**

Identification. Antipyrine may be in urine, which should be made alkaline, then antipyrine extracted with chloroform. *Test 1.* (a) Aq.

potassium nitrite; (b) dil. H_2SO_4. Unknown in water + 1 cc. (a) + 1 cc. (b). Green crystals = antipyrine. (Nitroso test.) Fading blue-violet = aminopyrine. *Test 2.* (c) Aq. 10% $FeCl_3$. Unknown solution + drop (c). Deep red = antipyrine.

Symptoms and Treatment. Same as for **Acetanilid.**

APOMORPHINE ($C_{17}H_{17}O_2N$) is an artificial alkaloid made from morphine by removing two molecules of water from the morphine structure. Apomorphine is a white, crystalline substance that oxidizes rapidly, the aqueous solution turning green on exposure to air and light.

It is used medically as a heart depressant, emetic, hypnotic, and expectorant; and as a sedative in acute alcoholism. The compound apomorphine hydrochloride is used in injections; if the solution is not fresh, poisoning may result.

Prescribed dose of apomorphine administered subcutaneously as an emetic is $\frac{1}{60}$ grains, or 0.001 gram. The fatal amount is very indefinite.

Identification. (a) 3% H_2O_2; (b) chloroform; (c) crystals potassium dichromate. To unknown residue add 1 cc. of (a) + 2 cc. (b) containing a crystal of (c). Blue, violet, and finally dark blue solution when shaken = antipyrine, apomorphine, or strychnine (Heich's test).

Symptoms. When given hypodermically apomorphine causes, in a few minutes, intense nausea and vomiting, pallor, flow of tears, exhaustion, and collapse.

Treatment. Summon a physician. Keep the patient quiet, recumbent, warm by applying external heat. Give aromatic spirits of ammonia (1 teaspoonful in ½ glass of water), or ammonia by inhalation. Treat for morphine poisoning after emetic effects are gone. Administer artificial respiration if necessary.

ARNICA, leopard's bane, mountain alkanet, mountain tobacco, or wolf's bane is obtained from the dried flower heads of the *Arnica montana* L., Compositae, a plant growing throughout the northern hemisphere. Arnica is commonly used externally as a counterirritant

to sore muscles, bruises, sprains, and strains. The quantity that is lethal varies; but arnica can produce fatal results in a short time.

Identification. Characteristic odor.

Symptoms. Nausea and vomiting; slow, weak pulse; subnormal temperature, pallor.

Treatment. Summon a physician. Keep the patient warm and quiet, give an emetic to produce vomiting; give medicinal charcoal, follow with raw eggs, milk or other demulcent drinks, oatmeal, or cereal gruels.

External Treatment. Wash thoroughly with soap and water.

ARSENIC (As) or arsenium is a brittle, steel-gray, lustrous, crystalline solid. Its compounds are poisonous, Paris green being an important copper salt of arsenic.

Arsenic and its compounds are used for hardening metals; in alloys, rat poisons, flypaper, tree and garden sprays, paper glazes, dyes, pigments, wallpapers, etc.

Arsenic compounds are used more than any other class of poisons because of their odorless and almost tasteless qualities. In several cases they have been introduced into the vagina, rectum, or urethra. They have also been used to induce abortion. The poisoner would either give a large dose or administer several smaller doses to simulate a natural illness. Cases of suicidal and accidental poisoning frequently occur as a result of ingesting rat poison or Paris green. Poisoning can also occur from eating vegetables and fruit from areas where a spray was used. The intensity of the toxemia depends on the amount of the arsenic ingested, and the speed with which it enters the blood. When administered in solution the absorption is faster than when given in a solid form. The acid found in the stomach will act as a solvent. The lethal dose of most arsenic compounds varies from 0.1 to 0.5 gram; although woodcutters have accustomed themselves to such doses, which enable them to carry heavy loads with ease.

Identification. Many tests for arsenic and antimony do not work unless organic matter is destroyed. The Reinsch test (Test 2) works

with some but not all organic arsenicals. Try the spot tests, page 16; if these give no positive tests for arsenic (or antimony), assume that there may be organic matter present, and proceed to destroy organic matter as follows (Stryzowski method). (a) Aq. saturated magnesium nitrate made alkaline with magnesium oxide. Gently heat 20 grams of unknown with 10 cc. (a) in a porcelain casserole. The mass softens and chars. Then heat more strongly; this gives a gray ash of magnesium pyroarsenate ($Mg_2P_2O_7$) and magnesium pyroantimonate ($Mg_2Sb_2O_7$). Soak the ash in 25 cc. water; filter and use the clear solution for the following tests. *Test 1.* See spot tests, page 16. The yellow sulfide forms only slowly. *Test 2.* (Reinsch test. All reagents must be arsenic-free; confirm this by running a blank, in the absence of unknown.) (b) Arsenic-free dil. HCl; (c) arsenic-free burnished copper foil. Acidify 10 cc. of the unknown solution with (b) until it is barely pink to litmus. Now add (c), and boil for 30 minutes, adding water from time to time to replace that lost by evaporation (the acid must not become too concentrated). Foil turns black or brown = arsenic, antimony, silver, mercury, or bismuth. Wash foil under running water, then place in small, closed tube, and heat gently. Deposit vaporizes and deposits further up the tube (sublimes) = arsenic; the other metals do not sublime. *Test 3.* (Gutzeit modification of Marsh-Berzelius test; will not work with many organic arsenicals unless treated according to the Stryzowski method, described above.) (d) Arsenic-free mossy zinc; (e) arsenic-free dil. HCl; (f) aq. 5% mercuric bromide. Place a piece of (d) in tube with unknown; add 5 cc. (e). When bubbles are evolved, hold filter paper dipped in (f) to mouth of tube. Paper turns yellow-red = arsenic, hydrogen sulfide, or other reducing agent.

Symptoms. The symptoms do not usually appear until about ½ to 1 hour after the poison is taken. The victim will have a burning sensation in the throat, pain in the stomach, pallor, nausea and vomiting, abdominal cramps, and thirst; cold, moist skin; slow, shallow breathing; rapid, thready pulse; coma, convulsions, collapse.

Treatment. (Arsenic compounds.) Summon a physician. Empty the stomach at once with an emetic (mustard or 30 to 60

grains of zinc sulfate in water). Also give Epsom salts in water (1 tablespoonful) followed by 30 grains of potassium bromide in water. Give plenty of water to replace fluids lost from the alimentary canal. Protect the membranes with raw eggs and milk. The official U.S.P. antidote is hydrated oxide of iron and magnesia.

Other Poisons. The treatment given above can be used also for victims of cobalt salts, as well as the arsenic compounds in ant pastes, arsenites, arsenous acid (white arsenic), Donovan's solution, fly-paper, Fowler's solution, Paris green, rat poison, Rough on Rats, Scheele's green, and other arsenic insecticides.

ATROPINE ($C_{17}H_{23}O_3N$), atropia, or atropina is an alkaloid obtained from the roots of the *Atropa belladonna* L. and some other Solanaceae plants. Intensely poisonous, it forms white odorless crystals, which have a bitter acrid taste.

Atropine or its salts are used to control spasms, and to stimulate respiration. It is used internally for a large variety of purposes by the physician; but its violently poisonous nature makes it dangerous in the hands of anyone but an expert. Applied on the skin, usually as the sulfate, oleate, or other salt of atropine, it relieves pain by paralyzing sensory nerve endings on the skin, and is often used for this purpose in the form of a belladonna plaster.

Prescribed dose is $\frac{1}{150}$ grain, or 0.0004 gram. Dangerous symptoms and death have resulted from 0.1 gram of atropine for adults, and 0.01 gram for children.

Identification. *Test 1.* (a) Fuming HNO_3; (b) alcoholic potassium hydroxide. Moisten residue with (a) and evaporate to dryness in tube in a stream of steam from a kettle. Cool. Add few drops (b). Violet, turning red, finally turning colorless = atropine group. (Vitali's test.) *Test 2.* (a) Hydrobromic acid saturated with bromine; unknown + (a) = yellow precipitate, amorphous turning leaflike = atropine. Brown globules possibly turning leaflike = scopolamine.

Symptoms. Excessive thirst and dryness of the mouth and throat, difficulty in swallowing, dry flushed skin, rapid pulse, rapid respirations which become slow and shallow, pupils dilated, talkative,

confused, may become quarrelsome, convulsions, stupor, coma, collapse.

Treatment. Summon a physician. Wash out the stomach with 5% tannic acid solution, or give an emetic of mustard water; apply ice to the head. Apply artificial respiration if necessary. Use black coffee as stimulant. Keep warm and quiet.

Other Poisons. Belladonna, daturine, suboisine, hyoscyamine, scopolamine, hyoscine, solanine, and stramonium same treatment as for **Atropine.**

BARBITAL [$(C_2H_5)_2C_3H_2O_3N_2$], barbitol, barbitone, diethylbarbituric acid, diethyl malonylurea, or veronal is an odorless, white crystalline powder with a faintly bitter taste.

It is prescribed by some physicians for internal use to quiet convulsions, and during the intervals between epileptic fits; for seasickness, for simple insomnia, as a sedative to quiet nerves and lessen hysteria, to lower blood pressure, and for relief from neuralgia pains and headache.

Soluble barbital is a water-soluble sodium salt, particularly suited for injections. Doses, effects, and treatment are similar to those for ordinary barbital.

An average dose (5 grains, or 0.3 gram) causes the patient to fall into a deep sleep, which lasts from 4 to 8 hours. On awakening, the patient often has dizziness and headache. Barbital is reasonably safe in small doses. Death has resulted from 1 gram; on the other hand recovery has followed after more than 8 grams were taken.

Identification. *Test 1.* (a) Aq. sodium bicarbonate. Boil unknown with (a). Ammonia liberated = barbital. *Test 2.* (b) Glacial acetic acid; (c) aq. mercuric chloride; (d) dil. NaOH. Dissolve unknown in (b). Then few drops of (c), then (d). White precipitate = barbiturates.

Symptoms. With an overdose, the victim is mentally confused and drowsy; coma follows. Pulse rapid, weak, irregular; skin moist; blood pressure low; cyanosis; the pupils usually constrict, but may be dilated; collapse follows.

Treatment. Summon a physician. If patient is conscious, give an emetic of mustard and water; use strong black coffee as a stimulant; keep the patient awake by slapping with a wet towel across the neck, back, and face; keep warm with blankets and external heat until the physician arrives. If necessary administer oxygen to relieve cyanosis.

Other Poisons. Allonal, amytal, dial, ipral, neonal, pentabarbital (nembutal), phenobarbital, and other barbiturate derivatives same treatment as for **Barbital.**

BARIUM (Ba) is a silvery metal belonging to the alkaline earths. As a free metal it has no importance. Many compounds are derived from barium, most of which are white in color, yellowish if impure. All water and acid soluble compounds of barium are poisonous. The compounds are widely used in industry for printing fabrics; in rat poisons, ceramics, paints, enamels, pigments, explosives, and matches; in the manufacture of optical glasses and paper; in boiler compounds for softening water, etc.

The action of the poison is rapid and may kill within 1 hour, but in some cases the victim lives a few days. The fatal dose is variable; approximately 1 gram has caused death of an adult; although in some cases recovery has followed after much larger doses had been taken. Death usually results from paralysis of respiration.

Note that in obtaining X-ray photographs of the alimentary canal, barium sulfate carefully freed of all soluble barium salts is swallowed; but that barium sulfide and barium sulfite are very poisonous.

Identification. *Test 1.* Flame test, page 17. Flame green = barium. *Test 2.* (a) Aq. ammonium carbonate. (b) dil. acetic acid; (c) aq. potassium dichromate. Aq. unknown + 1 cc. (a). White precipitate may be barium carbonate. Dissolve precipitate in (b); add (c). Yellow precipitate of barium chromate = barium.

Symptoms. Nausea and vomiting, abdominal cramps, diarrhea, salivation, paralysis of the arms and legs, pallor.

Treatment. Summon a physician. Give Epsom salts (1 tablespoonful) followed by an emetic; repeat; follow with milk and water. Keep the patient warm and quiet.

BELLADONNA, banewort, deadly nightshade, death's herb, dwale, or poison black cherry is a mixture of alkaloids obtained from the dried leaves and tops of the *Atropa belladonna* L. and some other Solanaceae plants. The leaves and root contain 0.3 to 0.4% total alkaloids, chiefly atropine, hyoscyamine, and scopolamine; and are used as sources of the alkaloids. Normal dose is ½ to 2 grains (30—120 mg.); maximum dose is 3 grains (200 mg.).

Identification. Same as **Atropine.**

Symptoms. Nausea and vomiting, abdominal cramps, diarrhea, salivation, paralysis of the arms and legs, pallor, weakness, and general paralysis.

Treatment. Summon a physician. Wash out the stomach with 5% tannic acid solution; give emetics; apply ice to head; apply artificial respiration if necessary. Use black coffee as a stimulant. Keep warm and quiet.

BISMUTH (Bi) is hard, brittle, and grayish-white to reddish in color. Its compounds are usually white or light yellow.

The free metal is used in low-melting alloys such as those for electrical fuses, automatic sprinkler heads, fusible boiler plugs, and dental alloys. About 90% of all bismuth consumption is for medicines, principally for intestinal and stomach remedies. Bismuth carbonate and nitrate are used in X-ray examination of the esophagus and stomach. Most medicinals contain the **bismuthyl (BiO) radical,** such as $BiONO_3$ (bismuthyl nitrate, or bismuth subnitrate); this includes the common medicines bismuthyl subcarbonate, subgallate, and subsalicylate.

Poisoning is usually due to bismuth dressings being left on too long and is rarely fatal. Under certain conditions bismuth salts may become poisonous, but under ordinary circumstances even larger amounts are harmless.

Identification. See page 16, spot tests.

Symptoms. The symptoms, resembling those of mercury poisoning, appear slowly. Nausea and vomiting; excess flow of saliva; a

blue line at the junction of the teeth and gums; swelling of the gums, tongue, and throat.

Treatment. The symptoms usually disappear after the dressings are removed. Even in this case a physician should be summoned.

CAFFEINE ($C_8H_{10}O_2N_4 \cdot H_2O$), guaranine, methyltheobromine, theine, or trimethylxanthine is an alkaloid obtained from coffee, Paraguay tea, guarana, and kola nuts. It forms a white powder or long silky crystals, which are odorless and have a bitter taste. Usually tea contains from 1.5-3.5% caffeine.

Caffeine is used chiefly as a stimulant, for which purpose it is ideal because it increases the activity of almost every organ of the body. In small doses it stimulates muscular contraction and lessens fatigue; larger doses have an exactly opposite effect.

Poisoning from caffeine is rare. If it occurs it is usually acute poisoning, resulting from the "coffee habit." Normal dose is 1 to 4 grains (60 to 250 mg.).

Identification. *Test 1.* (a) Mayer's reagent. Neutral caffeine + Mayer's reagent give no precipitate; other alkaloids do. *Test 2.* (a) HNO_3; (b) dilute NH_4OH. Unknown + (a) + (b). Violet to red = caffeine, theobromine, theophylline.

Symptoms. Restlessness, headache, excitement, mental confusion, pain over the heart, palpitation of the heart, sleeplessness, high blood pressure, and rapid pulse.

Treatment. The symptoms usually disappear after the patient has stopped using coffee. A physician should be consulted in any event.

CALCIUM OXIDE (CaO), burnt lime, calx, quicklime, or unslaked lime is sold as dry, white or grayish-white lumps or powder containing about 95% CaO, the remainder being water. Care must be exercised if water is added to the lumps; this should be done only in an open vessel, with great caution, since steam is violently given off. Water "slakes" the lime to form **CALCIUM HYDROXIDE** [$Ca(OH)_2$], slaked lime, lime slurry, or limewater. The water solution may be clear or cloudy-white, with a saline taste. Lime, slaked or unslaked, is used in plasters, cements, mortars, whitewash, dehair-

ing of hides, as insecticide spray, and in medicine externally or mixed with oil to form a liniment.

Identification. *Test 1.* Flame test, page 17. Flame orange = calcium. *Test 2.* (a) Aq. ammonium carbonate; (b) dil. acetic acid; (c) aq. ammonium oxalate. One cc. unknown aq. solution + 1 cc. (a). White precipitate may be calcium carbonate. Dissolve in (b) and add 1 cc. (c). White precipitate of calcium oxalate = calcium.

Symptoms. Pain in the throat and stomach; nausea and vomiting; thirst; subnormal temperature; cold, clammy skin; rapid, weak pulse.

Treatment. Summon a physician regardless of whether injury is internal or external. Give dilute acids such as lemon or orange juice, vinegar, etc.; empty the stomach with emetics; give raw eggs and milk. Keep the victim warm and quiet.

External Treatment. Wash thoroughly with water, then with lemon juice or vinegar, and again with water.

CAMPHOR ($C_{10}H_{16}O$), gum camphor, or Formosa, Japan, or laurel camphor is obtained from an evergreen tree, the *Cinnamomum* (Laurus) *camphora,* Nees and Ebermeier Lauraceae, which grows in the Far East. Much of the camphor available in the United States today is synthetic **BORNYL CHLORIDE** ($C_{10}H_{17}Cl$), also known as chlorocamphane, terpene hydrochloride, or turpentine camphor, a substance that resembles camphor. It is manufactured from turpentine, and in 1932 it broke the Japanese camphor monopoly.

Industrially camphor is used for manufacturing celluloid, explosives, and fireworks; as an insect repellant; in lacquers; and for embalming.

Camphor is used internally as a heart and respiratory stimulant; as a sedative for nervousness and in hysteria; in cases of shock; and for colds, hiccup, and severe diarrhea. Externally it is used for toothache, neuralgia, and similar pains, boils, etc. Vapors are inhaled for head colds.

The products most likely to be swallowed are camphor liniment;

camphorated oil; camphoric acid or soap liniment. Average dose of camphor if taken orally or by injection is 3 grains or 0.2 gram. One gram or less may cause toxic symptoms in adults; in children this amount is fatal.

Identification. Water precipitates camphor, with characteristic odor, from non-aqueous solutions.

Symptoms. A hot, bitter taste; burning pain in the throat and stomach; nausea, colic and vomiting; headache, dizziness, poor vision; delirium; convulsions, weak pulse; pallor; cold, moist skin; collapse. The symptoms usually disappear after use of the drug is stopped.

Treatment. Summon a physician. Empty the stomach with emetics (zinc sulfate 20 grains, or mustard in water); give stimulants, such as black coffee; give ether to be inhaled; artificial respiration if necessary; keep patient quiet and warm.

External Treatment. Wash thoroughly with soap and water.

CANTHARIDES, Spanish fly, blistering fly, or blistering beetle from the dried insect, *Cantharis vesicatoria,* contains a powerfully poisonous principle known as cantharidin.

Applied locally cantharides causes redness of the skin. When taken internally it is an irritant.

It is used externally as a vesicant in pleurisy, synovitis, neuritis, subacute rheumatism, etc.; also in medicinal hair tonic. Its use for incontinence of urine has ceased because of the danger of nephritis.

The fatal dose varies from 1.5 to 3.0 grams. Cantharides is highly toxic, and poisoning has resulted from its use. It has also been used with criminal intent.

Symptoms. Burning sensation in the mouth and throat, followed by swelling and blistering, thirst, nausea, and vomiting; abdominal pain; salivation; bloody diarrhea; slow, feeble pulse; sometimes chills; delirium followed by collapse.

Treatment. Summon a physician. Empty the stomach several times with an emetic of mustard and water; follow with the whites

of several eggs and milk. (Give large volumes of water between emetics.) Keep the patient warm and quiet.

CARBON DIOXIDE (CO_2), carbonic acid gas, or carbonic anhydride is a colorless, odorless, noncombustible gas. It is used as an antiseptic in brewing; in carbonated beverages; and is compressed and stored as a liquid in steel cylinders for use in fire extinguishers, and for medical purposes (see below).

If carbon dioxide is cooled sufficiently, carbon dioxide snow, or Dry Ice, is formed; this is manufactured industrially to chill and preserve foods. Because it is heavier than air it may collect in low places, such as the floors of mines, brewery vats, etc.; and is a source of danger therefrom. Several persons were asphyxiated in Brooklyn in 1936 while working in the hold of a ship when solid carbon dioxide was being used as a refrigerant. Dry Ice causes severe blisters on the skin; this dangerous property is utilized in removing growths and birthmarks from the skin with a "snow pencil," a small rod of Dry Ice.

For medicinal use, the pure gas is never breathed, for it will cause death from asphyxia in a few minutes. Instead, 5% to 7% pure carbon dioxide is mixed with 95% and 93% oxygen; and this mixture is breathed to stimulate respiration.

A concentration of 3.5% or 35,000 parts per million is injurious if breathed for an hour. New Jersey limits working concentration to 0.5% or 5000 ppm.

Identification. If a tank of the suspected gas is at hand, run some into a glass. A burning match thrust into the glass will be extinguished. Bubble the gas through limewater; a white precipitate ($CaCO_3$) will form first, then redissolve, forming soluble $Ca(HCO_3)_2$ = carbon dioxide.

Symptoms. Unconsciousness and failure of respiration and circulation.

Treatment. Summon a physician. Oxygen, fresh air, external heat to body and extremities, artificial respiration if necessary. If the victim is conscious give a stimulant. Keep warm and quiet.

CARBON MONOXIDE (CO) (see also, chapter 5) present in automobile exhaust gas, coal gas, furnace gases, and illuminating gas, is formed by the combustion of carbon compounds. Carbon monoxide is a component of water gas and of producer gas, which are formed by passing water or air, respectively, over heated coke (carbon). Both gases are important industrial fuels, and are the starting materials for synthetic methyl alcohol, ammonia, gasoline, etc.

Carbon monoxide is the most widespread human poison on record. In poisoning by carbon monoxide, asphyxiation takes place because the hemoglobin of the blood has an affinity for carbon monoxide, and will absorb it over 300 times faster than it will take up oxygen. When the corpuscles become saturated with carbon monoxide there is no room for them to carry oxygen to the tissues, and asphyxia results. Unconsciousness results when the blood is about 30% saturated—this amount of saturation occurring in a very short time—and death at any point after this. New Jersey and Massachusetts have set an allowable working concentration of 100 ppm.

Identification. *Test 1.* (a) Dil. NaOH. Place 2 drops of patient's blood, and for comparison, 2 drops of a normal person's blood on porcelain plate. Add 2 drops of (a) to each. Pink precipitate slowly found = CO; (Kunkel's test) brown = no CO. *Test 2.* (b) Aq. 2% palladous chloride. Soak filter paper in (b). Dry. Sandwich this test paper between two strips of cellophane (Scotch) tape for it is sensitive to hydrogen sulfide and hydrogen in illuminating gas. Just before use, remove one of the pieces of tape. This paper exposed to carbon monoxide, hydrogen sulfide, gasoline vapors, etc. will turn gray (compare color with a covered strip).

Symptoms. Headache, giddiness, throbbing of the temples, nausea and vomiting, weak pulse, difficult breathing, loss of consciousness, death. There may be a bluish-red color on various parts of the skin. At times the vomitus is drawn into the trachea and produces death by suffocation.

Treatment. Remove to fresh air and begin artificial respiration at once. If available administer oxygen containing a mixture of 5 or

7% carbon dioxide. Keep the patient warm and quiet. Summon a physician.

CARBON TETRACHLORIDE (CCl_4) (see also page 138), benzinoform, perchloromethane, or tetrachloromethane is manufactured by chlorine reacting with carbon disulfide in the presence of antimony trichloride catalyst. Carbon tetrachloride is a clear, colorless, noninflammable, heavy liquid having a characteristic odor like chloroform. In the presence of a flame or hot metal, carbon tetrachloride is partially converted into phosgene, a highly toxic war gas.

Carbon tetrachloride is used as a fire extinguisher, for rendering gasoline noninflammable, as a degreaser for metals, for cleaning clothes, and as a solvent for many substances such as oils and fats, waxes and resins, varnishes and lacquers, and rubber.

Carbon tetrachloride is taken internally in small doses (40 minims; 2.5 cc.) to cure hookworm, for which it seems specific. But it is never administered to alcoholics.

Vapors of carbon tetrachloride may give acute poisoning in concentrations of over 1000 ppm.; 100 ppm. is legal in New Jersey and Massachusetts. The minimal fatal dose of liquid lies between 3 and 4 cc.

Identification. Odor of carbon tetrachloride on breath or vomitus. To distinguish carbon tetrachloride from chloroform: (a) Starch-iodide paper. Gently heat a drop of the unknown in a test tube for 1 minute. Then lower moistened starch-iodide paper into the tube. Blue due to chlorine liberated from CCl_4 acting on iodide = carbon tetrachloride. No color = chloroform.

Symptoms. Dizziness, headache, nausea, vomiting, subnormal temperature and a feeble pulse, coma, fever, uremia, death.

Treatment. Summon a physician. Give no oils. Avoid alcohol in any form. If carbon tetrachloride vapors have been inhaled, give patient fresh air or oxygen, and artificial respiration if necessary. If the liquid has been taken internally give 1 tablespoonful of Epsom salts in water; empty the stomach with an emetic of mustard and water; give a stimulant of hot, black coffee if the victim is conscious;

administer artificial respiration if necessary. Keep the patient warm and quiet.

External Treatment. Wash thoroughly with soap and warm water.

CHLORAL HYDRATE ($CCl_3CHO \cdot H_2O$) is a hydrated aldehyde. It has a pungent odor and a bitter taste, and forms colorless crystals. Chloral is made by passing chlorine into absolute alcohol or aqueous acetaldehyde, and the hydrate is produced by adding water to chloral.

Chloral hydrate is used medicinally and in organic synthesis. It is the material known as **knockout drops.**

The fatal dose is extremely variable since 2 g. has produced death, and on the other hand recovery has followed after 30 g. were taken.

Identification. The breath often has the odor of bananas or pears. *Test 1.* (a) Aq. sodium carbonate; (b) aq. saturated phloroglucin. One cc. of unknown + 4 drops (a) + 1 cc. (b). Lilac to orange to red = chloral hydrate or aldehydes; chloroform gives no reaction (Schonbein's test). *Test 2.* (c) Alcoholic potassium hydroxide; (d) aniline. Gently heat, with shaking, 2 cc. of unknown liquid containing 1 cc. (c) + 1 cc. (d). Offensive odor of phenylisocyanide = chloral hydrate, chloroform, and other organic halogen compounds, such as iodoform.

Symptoms. About 15 minutes after taking the drug the victim feels tired, and drowsy, and falls asleep. On awakening there is nausea and vomiting; contracted pupils; headache; sudden heart weakness; and a slow, feeble pulse; stupor; heart failure.

Treatment. Summon a physician. No alcohol. Empty the stomach with an emetic of tannic acid or zinc sulfate; repeat the emetic using quantities of water; give black coffee as a stimulant to increase heart and respiratory action; apply artificial respiration if needed. Keep the victim warm and quiet.

Other Poisons. Butyl chloral hydrate, croton chloral hydrate, and chloral amide same treatment as for **Chloral Hydrate.**

CHLORINE (Cl_2) (see also page 138) is a greenish-yellow gas obtained from common salt. One of our most important industrial gases, chlorine is liquefied under pressure and shipped in tank cars to be used to purify water, to bleach cloth and wood pulp, and to make numerous industrial chlorinated products.

Fortunately chlorine has such an irritating odor that it gives ample warning of its presence. Its effect is merely temporary when breathed in moderate quantities; and recovery occurs after a short lapse of time. However, a concentration of 0.1% chlorine by volume will kill within a few minutes. A half-hour exposure to a concentration of 0.005% can cause serious injury and possibly death. Massachusetts set a working concentration of under 1 ppm.

Identification. Odor of chlorine in breath or vomitus. Chlorine bleaches wet colored cloth. *Test 1.* (a) Starch-iodide paper. Hold moistened paper in patient's mouth, or dip in vomitus. Blue = chlorine or bromine. *Test 2.* (b) Aq. silver nitrate; (c) dil. HNO_3; (d) dil. ammonium hydroxide. Two cc. unknown solution + few drops (b) + 1 cc. (c). White precipitate (AgCl); dissolves to form $Ag(NH_3)_2Cl$ if (d) is added carefully shake after each drop is added—in excess = chlorine.

Symptoms. Breathing chlorine causes edema of the lungs. The victim will find it difficult to breathe; the skin is pale, cold and clammy; the chest tight; and the pulse weak.

Treatment. Summon a physician. Remove to fresh air; allow victim to inhale ammonia fumes. Breathing fumes of ethyl alcohol bring speedy relief, possibly by paralyzing the nerves of the throat. Have the patient swallow starch or flour in water, then milk of magnesia; then white of eggs and milk; and finally an emetic of mustard or of zinc sulfate (30 to 60 grains) in water. Administer oxygen if available preferably breathing through a small tube or pipe stem to create a positive pressure and drive the fluid back into the lung tissue. Keep the patient warm and quiet. See **Chlorine Water,** below.

CHLORINE WATER, produced by dissolving chlorine gas in water, is a clear, yellowish liquid having a suffocating odor. This

solution is used as a disinfectant and deodorizer; and as a bleach for wood pulp, paper, cotton fabrics, and many other textiles.

Chlorine water owes its activity to HClO (hypochlorous acid), which chlorine forms with water; the oxygen in HClO is available to bleach and disinfect, just as excess oxygen in hydrogen peroxide bleaches or disinfects. There are a number of other household bleaches containing compounds chemically similar to HClO. They include: eau de Javelle, La Barraque's, Dakin's, and Carrel's solutions, which are potassium salts or sodium salts of hypochlorous acid (KClO and NaClO). Bleaching powder, or chloride of lime ($CaOCl_2$), another common household disinfectant, similarly owes its action to formation of HClO upon reaction with acid (e.g. vinegar).

Identification. Same as for **Chlorine,** above.

Symptoms. If chlorine water has been swallowed, the patient has a burning in the throat and stomach, nausea and vomiting, pallor, weak pulse, and difficult breathing.

Treatment. Summon a physician. If chlorine water has been swallowed, have patient sniff ammonia, or ethyl alcohol; give starch or flour in water; then milk of magnesia; then milk or white of eggs; and finally an emetic. Keep the patient warm and quiet; apply external heat to the body and extremities.

External Treatment. If chlorine water has been spilled on the skin, wash thoroughly with plenty of water; if the skin has been reddened, apply a paste of baking soda and water.

Other Poisons. Bromine and bromine water same treatment as for **Chlorine** or **Chlorine water.**

CHLOROFORM ($CHCl_3$), trichloromethane, or incorrectly formyl trichloride, is prepared by chlorine reacting with acetone or alcohol in the presence of lime; or by the reduction of carbon tetrachloride by hydrogen. Carbon tetrachloride is a colorless, clear, sweet-tasting, heavy liquid possessing a characteristic odor. It is very volatile.

Industrially it is a solvent for waxes, fats, and oils; for alkaloids; and in the rubber industry.

Chloroform is administered internally to check vomiting, seasickness, diarrhea, hiccup, tapeworm, and colic. It is inhaled as an anesthetic to check convulsions as in epilepsy, asthma, and for strychnine poisoning. Externally a 20 to 50% liniment is applied to soothe rheumatic and other local pains.

Dangerous symptoms do not appear unless an excessive quantity has been taken. Normal dose is 5 minims or 0.3 cc., usually diluted with alcohol, soap liniment, or water. Concentration of chloroform vapor of 80% by volume will kill in a few minutes. A ½-hour exposure to 1.5% may be lethal. Swallowing 1½ oz. of liquid chloroform may prove fatal.

Identification. Odor of chloroform on breath. (a) Pyridine; (b) aq. NaOH. Unknown 2 cc. (a) + 2 cc. (b). Boil for 1 minute. Pink to deep red = chloroform. See test under **Carbon Tetrachloride** for distinguishing from chloroform.

Symptoms. When too much chloroform is given, the following symptoms result: a slow, weak, and irregular pulse; pallor; dilated pupils having no reaction to light; a still further slowing of breathing and pulse; and finally death, from paralysis of the heart.

Treatment. Summon a physician. If chloroform has been inhaled, stop its use. Administer oxygen with carbon dioxide mixture; apply artificial respiration; alternate hot and cold water to face and chest. If the liquid has been swallowed, same as above for inhaled gas, but in addition use stimulants if patient is conscious. Keep patient warm and quiet. Give an emetic of mustard and water.

Other Poisons. Ether, laughing gas (nitrous oxide) same treatment as for **Chloroform.**

COCAINE ($C_{17}H_{21}O_4N$) or methylbenzoyl ecgonine is an alkaloid obtained from the leaves of the *Erythroxylon* coca and other *Erythroxylon* shrubs growing in South American countries. It forms colorless crystals or powder. This drug is easily decomposed and reacts to form many artificial alkaloids.

Cocaine is more often used in the form of cocaine hydrochloride (cocaine muriate, incorrectly called cocaine hydrochlorate). Either form is rarely administered internally. Externally they are used to

relieve pain and to check bleeding. Since cocaine preparations paralyze the nerve endings, minor operations are possible by deadening the feeling in the area affected.

Normal dose is ⅙ to 1 grain (10 to 60 mg.). One gram may produce death when taken by the mouth; 0.03 gram by the urethra.

Identification. (a) Aq. potassium dichromate; (b) conc. HCl. Add few drops (a) to aq. solution of unknown. Yellow precipitate, dissolves on shaking = cocaine. Now add a few drops (b). Orange-yellow needles precipitate = cocaine (Metzger's test).

Symptoms. Shortly after the absorption of a large dose the victim experiences restlessness, pallor, cold sweat, and dry throat. He may feel joyful and happy. Pupils are dilated. There may be nausea and vomiting; clonic or tonic convulsions follow. Subsequent symptoms that indicate that the patient's life is in danger are rapid pulse becoming slow and weak; rapid respiration becoming shallow and slow; more frequent convulsions; and coma. Finally, there is fatal collapse.

Treatment. Summon a physician. If cocaine has been swallowed, give tannic acid followed by an emetic to evacuate the stomach; reassure patient; give medicinal charcoal and ammonia by inhalation; apply ice to head. Treat convulsions by inhalation of ether or chloroform. Keep patient warm and quiet.

CODEINE ($C_{18}H_{21}O_3N \cdot H_2O$) or methylmorphine is an alkaloid obtained from opium, or by the methylation of morphine. Codeine forms colorless, odorless white crystalline powder or crystals. It is used as a free alkaloid, and as the sulfate or other salts as a hypnotic, sedative, and a substitute for morphine as an analgesic. Normal dose of codeine sulfate is ½ grain or 0.03 grams. Amounts of 4.5 grains or more are dangerous.

Identification. (a) Molybdic acid; (b) conc. H_2SO_4. To 2 mg. (about size of rice grain) of unknown add 1 cc. of (a) + 1 cc. (b). Blue = codeine or morphine. Red = brucine. Yellow = aconitine. Green = apomorphine.

Treatment. Summon a physician. The best known chemical antidote is potassium permanganate, given orally (10 grains in a pint of warm water), and repeat in ½ hour. Do not allow the patient to go to sleep, but avoid exercise such as walking to keep him awake. Give strong black coffee. Put ice on head, and external heat to the extremities. Apply artificial respiration, using oxygen if necessary. The physician will administer respiratory stimulants if he deems it necessary.

Other Poisons. Laudanum, morphine, opium, and paregoric same treatment as for **Codeine.**

COPPER (Cu) is a reddish, lustrous, malleable metal. It is produced in the form of sheets, wire, ingots, or powder and is not toxic in the metallic state. Some of the salts, however, are occasionally the cause of fatal poisoning. The copper salts of toxicologic significance follow.

CUPRIC ACETATE and other acetates, such as copper subacetate, green verdigris, are greenish-blue powders; have a faint acetic odor; and are used as an escharotic, also in the manufacture of Schweinfurth green and other pigments, in insecticides, in dyeing and printing fabrics, etc.

COPPER ACETOARSENITE, Schweinfurth, Imperial, Vienna, Parrot, or Paris green is an emerald-green powder used as a pigment, particularly against barnacles on ships and submarines, and as an insecticide and wood preservative.

CUPRIC ARSENITE, copper arsenite, Scheele's mineral, or Swedish green is a yellowish-green powder used as an insecticide and base for many green copper pigments.

The fatal amount is uncertain since a portion is usually vomited. Most cases survive a few days but one victim died in a few hours from ½ ounce of the subacetate.

CUPRIC SULFATE ($CuSO_4 \cdot 5H_2O$), bluestone, blue copperas, blue, Roman, or Salzburg Vitriol is blue, transparent, large crystals or blue granules or light powder. It is used as an escharotic, styptic, astringent, and emetic; also in dyeing cotton and silk, tanning leather,

engraving, destroying algae in pools; in copper soap, tin-marking ink, hair dye, insecticide mixtures, electric batteries, etc.

Identification. *Test 1.* See page 16, spot tests. Cupric salts in water solution are blue, or greenish-blue. *Test 2.* (a) NH_4OH. Unknown aq. solution + (a) in excess. Deep blue or purple solution = copper. *Test 3.* (b) Potassium ferrocyanide. Unknown aq. solution + (b). Red precipitate of $Cu_2Fe(CN)_6$ = copper.

Symptoms. Nausea and vomiting of greenish material, diarrhea with dark green stools, symptoms of collapse and heart failure.

Treatment. Summon a physician. Chemical antidote is the yellow prussiate of potassium (potassium ferrocyanide) 5 to 15 grains in water; or sodium thiosulfate; evacuate stomach; give raw eggs and milk abundantly, and plenty of water; apply external heat.

CRESOLS ($CH_3C_6H_4OH$) or hydroxytoluenes, of which there are three, are present in coal tar, but are usually manufactured from other coal-tar intermediates. A number of disinfectants, germicides, and antiseptics on the market contain mixtures of these cresols suspended in water or oil. All of them are much more dangerous than phenol (which chemically is the same as the cresol molecule only with H substituted for the CH_3 group). Usually some phenol is also present as an impurity.

CREOLIN, CREOLIN-PEARSON, or **CRESOTAL** is a water emulsion of coal-tar phenolics used in a 1 to 3% solution as a deodorant, disinfectant, and germicide; 1 to 2% solutions have been used for sterilizing cuts.

CREOLIN VETERINARY is a 2% aqueous or 10% oil emulsion for cuts, ulcers, and parasite-wash for animals.

WOOD CREOSOTE is a mixture of phenolics, particularly **creosol** (3-methoxy-4-hydroxy-methyl benzene), and **guaiacol** (methyl-catechol). It was first obtained from beechwood tar. Internally it is used for diarrhea, seasickness and stomach disorders; and is also inhaled for such lung troubles as tuberculosis or bronchitis. Externally the dilute solution has been used for chilblains and ulcers.

COAL-TAR CREOSOTE on the other hand contains more poisonous phenolics from coal tar; they are in the fraction which distills in the range 230-270° C. The investigator should confirm, if a physician has prescribed creosote to be taken internally, that only wood creosote and not coal-tar creosote has been taken. It is just such errors as these that the investigator must be careful to distinguish. Approximately seven grams is considered a fatal dose.

CRESOL, CRESYLOL, or **TRICRESOL** is a colorless, yellowish, brownish-yellow, or pinkish liquid, which darkens on age; it has a phenolic odor. Cresol is used as a disinfectant and antiseptic and is alleged to be 3.6 times more powerful than phenol. Normal dose is 1 minim or 0.06 cc. Fatal dose is approximately the same as for phenol.

LYSOL or **LYSITOL** a trade-marked product, is essentially 50% cresol suspended in a vegetable oil (i.e. linseed oil) soap. It is primarily used in solutions of 1% or less for douches and irrigations, also for cleaning walls and floors..

Identification. Same tests as for **Phenol.**

Symptoms. Burns on the mouth and lips; pain in the throat and stomach; nausea and vomiting; headache and dizziness; pallor; cold, moist skin; collapse.

Treatment. Summon a physician at once. Use no oils, fats, or greases. Give an emetic or 60 grains of zinc sulfate in a glass of warm water, and immediately follow with one tablespoonful of Epsom salts in water; finally administer raw eggs and milk to protect the membranes; treat collapse with heat stimulants. Keep patient warm and quiet.

External Treatment. Washing the burns with alcohol or whiskey is commonly recommended in the textbooks, but according to F. R. Davison is of doubtful value because the alcohol solution of cresol will itself be quickly absorbed into the system. If there is so much cresol on the burn that an alcohol wash is imperative; (1) wash thoroughly with water; (2) give a rapid alcohol or whiskey flush; (3) within a few seconds wash off the alcoholic solution with more

water. It is *absolutely essential* to follow these steps in the order given.

Other Poisons. Creosote, cresols, guaiacol, and other phenolic coal-tar products same treatment as for **Phenol.**

CROTON OIL or oleum tiglii is a thick, yellowish fixed oil (an oil that does not evaporate) pressed from the seeds of the *Croton tiglium* L., a shrub found in parts of southern Asia.

Croton oil is given by some physicians internally, in diluted form, to persons unwilling or unable to swallow medicine; to maniacs who refuse to swallow medicine; and in cases of apoplexy when the patient is unconscious. Externally a 50% solution in sweet oil is rubbed on locally for colds, for rheumatism, and for toothache.

Identification. Oily. Blisters the skin.

Symptoms. Pallor, severe griping pains, violent purging and collapse; it causes redness and irritation on the skin; may cause blisters on mucous membranes.

Treatment. Summon a physician. Evacuate stomach with an emetic, give plenty of water, apply external heat, and give raw eggs and milk.

DIGITALIS, fairy gloves, foxglove, or purple foxglove is obtained from the dried leaves of the *Digitalis purpurea* L., Scrophulariaceae, found in southern and central Europe, and cultivated in the United States.

Various digitalis preparations, and their normal doses are as follows. (1) **Difoline,** solid in solution, of which 1 cc. is equivalent to $\frac{1}{10}$ grams digitalis; or 1 tablet to $\frac{1}{10}$ gram of the leaf; (2) **digalen,** a 26% alcohol solution, dose 1-2 cc.; (3) **digitalinum verum,** digitalinum true, or Schmiedeberg's digitalin ($\frac{1}{30}$ grain); (4) **Hormolle's digitalin** (French), or chloroformic digitalin ($\frac{1}{240}$ grain, then rapidly increased to $\frac{1}{40}$ grain); (5) **Walz digitalin** (German) ($\frac{1}{10}$ to $\frac{1}{2}$ grain up to 1 grain); (6) **digitalis U.S. P. XI** (2 grains); (7) **digitalon,** an aseptic solution ($\frac{1}{2}$ to 1 cc.); (8) **digitan,** a purified extract (1 cc. or $\frac{1}{10}$ gram); (9) **digitonin** or digitin,

which has no heart action; and (10 **digitoxin,** the most active and toxic glucoside of the digitalis purpurea (1/240 to 1/60 grain).

Digitalis is used as a stimulant in disease of the heart, especially with fibrillation; also to stimulate flow of urine.

Death can result from an overdose of the drug; 2.5 grams of digitalis has been fatal; and only 1/10 grain of digitoxin has killed in a few hours.

Identification. May be in vomitus. (a) Conc. H_2SO_4; (b) bromine. Unknown treated with (a). Green, not decolorized by (b) = digitoxin; orange-yellow, turning cherry or violet with (b) = digitalin. Red, intensified with (b) = digitonin. Green, not decolorized by Br = digitoxin. Emerald green turning brown = strophanthin.

Symptoms. Nausea and vomiting; diarrhea and pain in the abdomen; slow, weak, and irregular pulse; weakness; headache; poor vision; dizziness. Pulse becomes rapid at the slightest exertion.

Treatment. Summon a physician. Evacuate the stomach with 60 grains of tannic acid to one pint of water; absolute rest and quiet for several days; keep warm and apply external heat, also heat to the region of the heart. Apply artificial respiration if necessary.

Other Poisons. Digitalin, digitoxin, quabain, squill, strophanthin, strophanthus, and other digitalis preparations same symptoms and treatment as **Digitalis.**

ERGOT, secale cornutum, or spurred rye is obtained from *Claviceps purpurea,* a fungus growth that develops on rye plants in Europe. Ergot contains many alkaloids, some of which are: ergocristine, ergonovine, ergosive, ergotamine, ergotinine, and ergotoxine. The mixture has a very unpleasant taste.

Ergot is given to check bleeding from the uterus; or to contract the uterus in childbirth; in this latter instance it is never administered until after the placenta has been expelled.

Normal dose is 8 grains or 0.5 gram. Since ergot preparations vary in their content it is difficult to state definitely the fatal dose. Death has resulted after 12 grains were taken; and on the other hand recovery has followed a dose of 150 grains.

Identification. With ergot the vomitus will have a nutty odor. (a) Ether; (b) dil. KOH; (c) aq. sodium oxalate; (d) conc. H_2SO_4. Prepare extract of unknown in (a). Test as follows. Portion 1: Heat (care for ether near flame) with (b). Fishy odor of trimethylamine = ergot. Portion 2: Unknown extract + (c). Red = ergot. Portion 3: (Tanret's test) Pour (d) upon unknown extract. At junction, orange turning blue = ergot.

Symptoms. Poisonous doses usually produce nausea and vomiting, cramplike pains low in the abdomen, diarrhea; an itching and tingling of the skin; slow, weak pulse; pain around the heart; shortness of breath; muscle spasms; and possible convulsions and coma before death.

Treatment. Summon a physician. Wash out the stomach with an emetic (zinc sulfate, 20 grains) or mustard. Give a teaspoonful of medicinal charcoal; give stimulant of hot black coffee. Keep the patient warm and quiet.

ETHER ($C_2H_5OC_2H_5$), diethyl oxide, ethyl ether, ethyl oxide, sulfuric ether, or sulfuric ethylic ether is a clear, colorless, very volatile and very inflammable liquid, with a burning taste and a characteristic odor. Vapors of this compound are explosive when mixed with air. Ether is manufactured by partially removing water from alcohol at 135° C. with sulfuric acid. (Hence the name sulfuric ether.) Ether is an important organic solvent for waxes, oils, fats, gums, perfumes, and for alkaloids; it is used in making dyes, collodion, smokeless powder; and for cleaning fabrics. It is stored in a copper-lined container, or a container having a spiral of copper wire, which prevents decomposition into substances that would impair its anesthetic properties.

Ether is taken internally to control spasms in hiccup, and as a stimulant in fainting or collapse. Its most familiar use is as an inhalation anesthetic. Externally ether is used in earache, toothache, and neuralgia; and to facilitate removal of adhesive tape in surgical dressings.

U.S.P. ether contains about 2.5 to 3.5% alcohol, and about 0.5% water.

Normal dose is 15 minims or 1 cc. As a vapor 3.5% by volume can produce unconsciousness. 400 ppm. is a working concentration according to Massachusetts law. One ounce of liquid has proved fatal in minutes to hours.

Identification. Odor on breath.

Symptoms. Use of too much ether produces a slow, shallow, and gasping breath; the face becomes blue; blood pressure falls rapidly; pupils are widely dilated and do not react to light; pulse grows weaker; and death results from respiratory failure.

Treatment. Summon a physician. If ether is being inhaled, stop use; administer oxygen with a carbon dioxide mixture; apply external heat and artificial respiration if necessary; lower head; have victim inhale ammonia. If the liquid has been swallowed, give same treatment as for inhaled gas, but also use emetic.

Other Poisons. Chloroform and laughing gas (nitrous oxide) same treatment as for **Ether.** See **Chloroform.**

FORMALDEHYDE (HCHO), formalin, formic aldehyde, formol, methanal, methylene oxide, or oxymethylene is made by the oxidation of methyl alcohol vapors with air over hot copper. Commercial "40% formalin" contains 40 g. of formaldehyde per 100 cc. of solution; actually this amounts to 37% formaldehyde per 100 cc. water. Formalin solutions become cloudy with age, or when hot or in the light; this is due to formation of a polymer, paraformaldehyde. To prevent this polymerization, commercial formalin usually contains 10 to 15% methyl alcohol.

Formalin is used in embalming fluids, for anatomical specimens, for hardening photographic film, in formaldehyde-phenol plastics, and elsewhere.

It is used as a germicide, antiseptic, and deodorant. A 0.5% wash is available for wounds and abscesses.

The vapors act chiefly on the upper respiratory tract. Twenty ppm. is the concentration allowable for working in Massachusetts. One ounce has caused death; the largest quantity from which recovery has been achieved is 2 ounces.

Identification. Odor on breath. (a) Aq. 5% phenylhydrazine hydrochloride; (b) aq. 0.5% sodium nitroprusside; (c) aq. NaOH. Mix 3 cc. unknown liquid + 10 drops (a) + 2 drops (b) + 10 drops (c). Blue, turning green, then yellow-red = formaldehyde. Red = acetaldehyde.

Symptoms. Nausea and vomiting, pallor, cold clammy skin, reddening of the eyes and mouth, a burning in the throat and stomach, and collapse.

Treatment. Summon a physician. Empty the stomach with an emetic at once. Allow the patient to inhale ammonia fumes. Give a glass of water containing a few drops of ammonia as a chemical antidote. Give medicinal charcoal. Follow with raw eggs and demulcent drinks. Keep warm and apply external heat.

External Treatment. Summon a physician. Wash thoroughly with water, then with aromatic spirits of ammonia, and again with water.

GASOLINE (C_4H_{10} to $C_{13}H_{28}$) (see pages 152, 155) is a mixture of several hundred hydrocarbons, saturated and unsaturated. Its chief hazard is explosion and fire; for in order to poison from an hour's exposure, as much as 2% or 20,000 ppm. is required. New Jersey and Massachusetts stipulate a working concentration of under 1000 ppm. Of course leaded gasoline is extremely dangerous because of the tetraethyl lead it contains; also some gasoline containing high percentages of sulfur compounds may poison from hydrogen sulfide present.

Although the greater part of manufactured gasoline is used as a fuel in motor vehicles, the liquid has many other uses, for instance, as a solvent for fats and oils, and in special lamps and stoves for light and heat. Gasoline is increasingly important as a starting material for many large tonnage chemical industries: synthetic rubber, plastics, toluene, etc.

Death has been caused by a pint of this liquid.

Identification. Odor. Five drops on a bit of cotton burns with a smoky flame.

Symptoms. Headache, giddiness, flushed face, tendency to mania, nausea and vomiting, disturbed vision.

Treatment. Summon a physician. Remove gasoline-soaked clothing. Empty the stomach at once with emetics. Apply external heat and keep warm. Avoid alcohol or camphor as stimulants; use only black coffee or aromatic spirits of ammonia (1 teaspoonful in ½ glass of water). Artificial respiration and oxygen, if required. Rest is necessary.

Other Poisons. Benzene, kerosene, naphtha same treatment as for **Gasoline.**

HEROIN ($C_{21}H_{23}O_5N$), diacetylmorphine, or diamorphine, an artificial alkaloid made from morphine, is odorless, bitter white crystals or crystalline powder. It is usually taken by snuffing up the nose; but because heroin is so extremely habit-forming manufacture of it and of its salts are prohibited in the United States.

Both it and the hydrochloride are used internally as a sedative and antispasmodic against persistent cough, asthma, bronchitis, etc.

Death has been caused by 0.2 gram.

Identification. (a) Conc. HNO_3. Add 1 cc. water to 1 cc. (a). Shake with a pinch of unknown powder. Yellow solution gradually changing greenish-blue, then turning bright yellow (changes rapid on heating) = heroin. Heroin reacts with water to form morphine, and therefore gives many morphine tests.

Symptoms. Following a poisonous dose the symptoms are similar to those of morphine; a slow pulse; slow, shallow breathing; pupils contracted to a pin point; cyanosis; stupor; sleep; coma, profuse perspiration; collapse.

Treatment. Summon a physician. Wash out the stomach immediately with a potassium permanganate solution, which makes the drug inactive. Repeat washing every 30 minutes until patient is out of danger; follow each washing with an emetic of 1 tablespoonful of mustard in a glass of water. Apply artificial respiration if necessary. Keep the patient warm, quiet, and awake.

HYDROGEN PEROXIDE (H_2O_2), hydrogen dioxide or di-

oxygen, is manufactured by the action of dilute sulfuric acid or of carbon dioxide on ice-cold barium dioxide in water. The household variety is a colorless, bitter to sweet, 3% aqueous solution inhibited against decomposing by a trace (1/6 grain per pint) of acetanilid. In industry a concentrated, dangerously caustic solution is used, one of which **Superoxol, or Perhydrol,** is a 30% aqueous solution. Hydrogen peroxide is used extensively as a bleaching and oxidizing agent in many chemical industries.

Medicinally the 3% solution is used as a cleansing agent, antiseptic, and deodorant as in gargles, or applied to abscesses, tonsils, etc.; for bleaching teeth; and for counteracting certain toxins.

Normal dose is 60 minims, or 4.0 cc. of the 3% solution.

Identification. (a) Solid manganese dioxide. To unknown solution add a pinch of solid manganese dioxide. Bubbling; gas coming off (oxygen) causes glowing splint to burst into flame = hydrogen peroxide.

Symptoms. Nausea and vomiting, pallor, and a weak pulse.

Treatment. Summon a physician. Empty the stomach with an emetic, keep warm by applying external heat.

HYDROGEN SULFIDE (H_2S), stink damp, or sulfuretted hydrogen is the familiar evil-smelling gas similar to eggs long decomposed noticed in analytical chemistry laboratories. It is manufactured by the action of acid on ferrous sulfide, and is also found in flue gases, coal gases, and other gases of organic origin.

It is used extensively as a chemical reagent in qualitative analysis, since it forms characteristic colored sulfides, by which a mixture containing unknown metals may be identified.

Hydrogen sulfide is a deadly poison, which ranks with hydrogen cyanide in danger. One part of the gas in 200 parts of air is fatal to man. New Jersey and Massachusetts have set 20 ppm. as a safe working concentration.

Identification. Odor of decomposing eggs. (a) Lead acetate paper. Paper (a) held to gas turns black (PbS) immediately = hydrogen sulfide.

Symptoms. Long exposure to small concentrations causes headache; dizziness; nausea; burning throat and cough; cramps; dilated pupils; greenish face, slow, weak pulse; coma; convulsions; and respiratory failure. High concentrations cause sudden unconsciousness, and death.

Treatment. Summon a physician. Remove to fresh air; apply artificial respiration; if available administer oxygen. Keep the victim warm and quiet.

IODINE (I_2) or iodum is a steel gray, nonmetallic element obtained industrially as an impurity from Chile saltpeter; some iodine is also obtained from California brines and seaweed ashes. It is used in photography, in manufacturing iodine compounds, and as an analytical reagent.

Iodine is given internally in goiter cases to counteract a deficiency of the thyroid gland; and as an antidote in phenol and cresol poisoning. Externally the most important application is in tincture of iodine, used on cuts and abrasions; and applied to external portions of the body as in lumbago, chilblains, ringworm, etc. There are many tinctures of different strengths. A strong tincture may contain as much as 16% iodine. On the other hand **Lugol's solution** is a mild water solution containing 4.5 to 5.3% free iodine made soluble by 10% potassium iodide; a few drops of this solution in water is used as an antidote (followed by stomach pump) in poisoning by alkaloids. One ordinary household type of **tincture of iodine** contains 7% iodine and 5% potassium iodide in ethyl alcohol.

The average dose for the 7% tincture when used internally is 1½ minims, or 0.1 cc. One fluid dram of the tincture is considered the fatal dose, although recovery has followed after a dose of 8 fluid drams.

Identification. Look for iodine or iodides in vomitus. *Test 1.* (a) Chloroform; (b) chlorine water. Vomitus + (a). Violet extract = iodine. If extract is colorless add (b). Violet extract = iodides. *Test 2.* (c) Starch such as flour or potato. Turns iodine blue-black.

Symptoms. Metallic taste in the mouth; sense of heat in the

throat and stomach; nausea and vomiting; diarrhea; rapid, weak pulse; cold, moist skin; shallow breathing; dilated pupils, cyanosis; convulsions; collapse.

Treatment. Summon a physician. Give starch or flour and plenty of water; empty the stomach with an emetic; apply external heat; use stimulants (black coffee, or aromatic spirits of ammonia); followed with demulcent drinks and raw eggs; keep patient quiet.

External Treatment. Summon a physician. Wash with alcohol, then soap and water.

IODOFORM (CHI_3) or tri-iodomethane is prepared from a dilute aqueous solution of sodium iodide in acetone, either by electrolysis in the presence of sodium carbonate or by addition of alkaline sodium hypochlorite. Iodoform is a yellowish crystalline powder, readily identified by its characteristic odor and sweetish taste.

It is used chiefly externally as an antiseptic for cuts, and to stimulate the growth of tissue.

Dose is 4 grains or 0.25 gram. Two grams of iodoform has caused death; and recovery has sometimes followed after 7 grams had been taken.

Identification. Characteristic sweetish "hospital" odor. Note under Chloral Hydrate that *Test 2* which gives phenylisocyanide, is a test also for iodoform.

Symptoms. Iodoform after being absorbed into the blood produces the following poisonous effects. In mild cases there is only a rise in temperature, headache, rapid pulse, and dizziness. In severe cases the patient believes he is being persecuted, and may attempt suicide; collapse may cause death.

Treatment. Summon a physician, who may give stimulants for collapse. Sodium bicarbonate (baking soda) is given with plenty of water, followed by an emetic to empty the stomach. Keep the patient quiet and warm, and ease his mental attitude.

LEAD (Pb) (see also page 147) is a flexible, heavy, bluish-gray, soft metal used in the manufacure of lead salts, shot, Babbitt and type metal, foil, solder, cable coverings, storage battery plates, etc.

Lead salts are rarely used internally because of the danger from lead poisoning. Externally they are applied as astringent and antiseptic lotions (acetate, nitrate, phenolsulfonate, and tannate); for skin diseases (carbonate); as irritant and counterirritant (iodide); in ointments (monoxide); and as a dusting powder (stearate).

Acute lead poisoning is rare. Chronic poisoning is caused by continued absorption of small quantities. It is dangerous because of accumulative effects on the blood vessels, heart, kidneys, and nervous system.

Lead tetraethyl is a very poisonous organic compound that is added to gasoline to increase its antiknock value.

No fatal dose for lead compounds can be definitely established. A soluble salt like the acetate may be lethal in amounts over 10 grams; and cases of recovery have occurred when about 30 grams were taken. The patient may die from collapse on the second or third day.

Identification. *Test 1.* See page 16, spot tests. Lead iodide is a bright yellow. *Test 2.* (a) Aq. potassium dichromate; (b) dil. acetic acid; (c) litmus paper. Three cc. water solution of unknown (preferably clear) + few drops (a). Add (b) until acid to litmus paper; a yellow precipitate of lead $PbCrO_4$ (lead chromate) = lead.

Symptoms. Victim may have headache, delirium, excitement, convulsions, blindness, paralysis, coma, a blue or black lead line on the gums, and collapse.

Treatment. Summon a physician. Give 2 tablespoonfuls in ½ glass of water of Epsom salts (magnesium sulfate) or Glauber's salt (sodium sulfate). Follow with emetics, demulcent drinks, and stimulants.

LYE (NaOH). See **Sodium Hydroxide.**

LYSOFORM is a mixture of formaldehyde and lysol, and is used primarily as a disinfectant in 5 to 10% solutions. Even these concentrations are dangerous; not too great amounts will produce death.

Identification. See tests for (1) **Formaldehyde** and (2) **Phenols.**

Symptoms. Lips and mouth will be burned, severe pain in the throat and stomach, pallor, nausea and vomiting, and collapse.

Treatment. Summon a physician. Evacuate the stomach immediately with plenty of Epsom salts followed with an emetic; give raw eggs and milk, and stimulants. Keep patient quiet and warm.

External Treatment. Summon a physician. Wash thoroughly with water, then with lemon juice or vinegar, and again with water

LYSOL. See **Cresols,** for which symptoms and treatment are the same.

MERCURY (Hg) or quicksilver is a heavy, silvery liquid metal obtained from red cinnabar. Two well-defined series of compounds are known, namely mercurous and mercuric. Many of these compounds are medicines; they are freely used to commit suicide and homicide; as well as taken by accident or erroneously. Salts most likely to be encountered are:

MERCURIC OXIDE (red precipitate and yellow precipitate). There is both a red and a yellow modification of the oxide; both are heavy powders, practically insoluble in water or alcohol. They are used in ointments for skin diseases.

MERCURIC CHLORIDE AMMONIATED, ammoniated mercury, white precipitate, or aminomercuric chloride, is a heavy, white powder.

MERCUROUS CHLORIDE, calomel, mild mercury chloride, mercury mono-, proto-, or subchloride, is a heavy, white powder.

MERCURY BICHLORIDE, mercuric chloride, corrosive sublimate, mercury-perchloride, or corrosive mercury chloride, is in the form of colorless crystals, white granules or powder. The average dose of mercury bichloride (corrosive sublimate) when administered internally is $\frac{1}{15}$ grain, or 0.004 gram; that is, it is extremely poisonous.

The investigator should be particularly on the alert to ascertain whether mercuric chloride (corrosive sublimate), which is extremely poisonous, has been used by mistake as a laxative in place of mercurous chloride (calomel) which is not so poisonous.

Identification. Mercury compounds are in stomach and intestines for first few hours; after a day are mostly in liver and kidneys; and after 4 days have been eliminated. *Test 1.* See page 16, spot tests. *Test 2.* (a) Conc. HNO_3; (b) conc. HCl; (c) fresh aq. stannous chloride. Dissolve unknown in mixture of 1 cc. (a) + 3 cc. (b). Few drops (c) gives gray (HgCl + Hg) to black (Hg) = mercury. *Test 3.* The Reinsch test described for arsenic salts works equally well for mercury salts.

Symptoms. Mercury poisoning occurs in two forms: chronic and acute. The symptoms resulting from swallowing a poisonous mercury compound, such as bichloride of mercury in solution or in tablet form are: a burning pain in the throat; a metallic taste in the mouth; cramplike pains in the abdomen; nausea and vomiting; rapid, weak, and irregular pulse; pallor; cold, moist skin; shallow and slow breathing; diarrhea; collapse. Coma and convulsions may occur before death. Death results from excessive vomiting and diarrhea, which causes collapse.

Treatment. Summon a physician. The preferred antidote is sodium formaldehyde sulfoxylate, which comes in 10-gram ampules. It is also sold as formaldehyde hydrosulfite, formaldehyde sodium sulfoxylate, Formopan, Hydrolit, or Rongalit. Dissolve 1 ampule in 250 cc. of water; have victim swallow or introduce with a stomach tube; then immediaely empty the stomach. Dissolve another ampule in 250 cc. of water, have victim swallow, and leave in the stomach. Apply external heat. If the preferred antidote of sodium formaldehyde sulfoxylate is not available, give an abundance of raw eggs followed by an emetic of mustard or zinc sulfate (30 to 60 grains) in water.

MORPHINE ($C_{17}H_{19}O_3N \cdot H_2O$), morphia, or morphina is the most important alkaloid obtained from opium. It forms white, bitter, lustrous prisms, fine needles, or crystalline powder, which darkens upon exposure to light.

Morphine, and particularly morphine sulfate, and other salts are commonly used to lessen pain, calm nerves, induce sleep, and quiet muscles. When administered by hypodermic its action is more rapid

Black Widow Spider.

Top—Edible mushrooms. *Bottom*—Poisonous mushrooms. (*Courtesy of American Museum of Natural History.*)

than when taken by ingestion. It is given internally only in very serious cases, because in many instances complications attend its use.

Dose of morphine sulfate is ⅛ grain or 0.008 gram; the fatal dose in a person who is not an addict is about 2 grains. The poisoning action is much faster in children. Most of the cases of morphine poisoning result from the administration of an overdose.

Identification. *Test 1.* (a) Neutral 5% $FeCl_3$ solution. Unknown powder plus few drops (a). Blue, which may fade = morphine; red changing to black = apomorphine; no color given by heroin or codeine. *Test 2.* (b) Iodic acid; (c) chloroform; (d) dil. NH_4OH. Warm 2 cc. (b); add few drops of unknown; shake; add equal volume of (c); shake; stand. Brown which deepens if few cc. of (d) added = morphine.

Symptoms. Physical ease and mental stimulation, with a quickened pulse, which lasts a variable length of time. This is followed by drowsiness, nausea, a desire to sleep, with a gradual loss of muscular power and sensitivity, contracted pupils; stupor grows deeper; and death occurs in a deep coma.

Treatment. Summon a physician. Potassium permanganate (10 grains) in a pint of warm water; repeat in ½ hour. Do not allow patient to sleep, but avoid exercise such as prolonged walking. Apply artificial respiration if necessary for 24 hours; apply heat; give strong black coffee. Apply ice to head and heat to the body extremities.

MUSHROOMS are a type of fungus growth. The species *Agaricus campestris* is edible, having been successfully cultivated for over 200 years. It grows only in open breezy pastures. The poisonous species *Amanita phalloides,* commonly called "toadstools," grows in wet, boggy places, in woods, and around tree stumps; it causes nine-tenths of all deaths from poisonous mushrooms.

Upon breaking mushrooms open the edible variety remains white, whereas the poisonous species often turns buff or brown.

Symptoms. Acute abdominal pains, vomiting, diarrhea, constipa-

tion at times; cold, clammy skin; cyanosis; jaundice; convulsions; coma; death.

Treatment. Summon a physician. Give an emetic of mustard or zinc sulfate (30 to 60 grains) in water; apply external heat, and administer oxygen if necessary. Stimulants if indicated.

NAPHTHALENE ($C_{10}H_8$), naphthalin or tar camphor, is a white crystalline coal-tar product. It is an important starting point for the manufacture of indigo and other dyes, synthetic resins, organic acids, celluloid, and smokeless powder. Moth balls are pure naphthalene. Another household repellant is paradichlorobenzene. Moth balls are not deadly poison, but swallowing them can cause great discomfort.

Identification. By the characteristic odor of moth balls.

Symptoms. Restlessness, depression, twitching, convulsions, urine dark brown to black, coma with snoring.

Treatment. Summon a physician. Give an emetic; give demulcent drinks such as milk or oatmeal gruel; stimulants if necessary.

NICOTINE ($C_{10}H_{14}N_2$) nicotia, or pyridyl-N-methyl-pyrrolidine, present in from 2 to 8% in tobacco leaves, is a very bitter, colorless to yellowish oily liquid, turning brown in the air. The liquid has a disagreeable odor, like pyridine. Solutions containing about 1% nicotine are used as a spray against plant lice and against the itch-mite in sheep. One drop of pure nicotine has killed in 15 minutes to an hour.

Identification. Strong tobacco odor. *Test 1.* (a) Ordinary "formalin" containing 37% formaldehyle; (b) conc. HNO_3. To 10 mg. of unknown residue add 1 drop of (a), then a drop of (b). Rose color = nicotine. Not given by aniline, coniine, or pyridine. *Test 2.* (c) Chlorine water. Unknown solution + (c). Red-brown precipitate = nicotine.

Symptoms. With large doses, tremors; palpitation; pupils first contract, then dilate; headache, dizziness; collapse and coma due to respiratory paralysis. Very large doses paralyze the nerves.

Treatment. Summon a physician. Give tannic acid followed by an emetic of mustard water; medicinal charcoal; stimulants; keep the extremities warm; cold applications to the head; apply artificial respiration if necessary.

Other Poisons. Lobelia, lobeline, and tobacco same treatment as for **Nicotine.**

NITROUS FUMES. See **Nitrogen Oxides,** chapter 5.

OPIUM is found as a milky liquid in the unripe fruit of the opium poppy, *Papaver somniferum* L., or *P. album,* De. C. (Papaveraceae), which grows in Asia and Africa, and is cultivated in the Balkan States, Hungary, and southern Russia. The liquid dries to a brown mass, and has a characteristic odor.

About 25% of the drug is active material in the form of some twenty alkaloids, of which morphine (approximately 16%) is present in largest quantities. Opium is used chiefly as a source of these alkaloids.

Opium preparations include: (1) the **crude gum opium,** containing between 10 and 16% of anhydrous morphine; (2) **deodorized opium** (morphine 10 to 10.5%), from which nauseating ingredients have been removed; (3) **granulated opium** (10 to 10.5% morphine) for preparing alcoholic solutions; and (4) **powdered opium** adjusted with inert sugar so that it contains 10 to 10.5% morphine.

Opium is used to produce sleep, relieve pain, and quiet nerves. When administered by hypodermic its action is more rapid than when taken by ingestion.

Normal dose of opium containing 10 to 10.5% anhydrous morphine is 1 grain or 0.06 gram. The fatal dose varies, but in one who is not an addict it lies between 2 and 4 grains, the action being much faster in children than in adults.

Identification. Opium being largely morphine, carry out tests for morphine.

Symptoms. Drowsiness, nausea, desire to sleep, a loss of muscular power and sensitivity, pupils contracted to a pin point, deep stupor, and death resulting while in a coma.

Treatment. Summon a physician. Have victim swallow 10 grains of potassium permanganate dissolved in a pint of warm water; repeat same in about 30 minutes. Give an emetic each time to remove the permanganate. Keep the patient awake without excessive physical exercise, such as walking too much; apply artificial respiration if necessary. Ice to head; heat to arms and legs, strong black coffee.

PHENACETIN ($C_{10}H_{13}O_2N$), acetophenetidin, acetparaphenetidin, ethoxyacetanilid, para-acetphenetidide, or para-acetphenetidin is prepared as a white, odorless, somewhat bitter powder or crystalline scales by boiling paraphenetidin with glacial acetic acid.

Phenacetin is similar in its action to acetamide, being used to reduce mild fevers, and for relief of nervousness, headache, and pain.

Normal dose is 5 grains or 0.3 gram, beginning with 3 grains for safety. The exact fatal dose is not positively determined, but 10 to 20 grains may kill a person with a weak heart, and 10 to 30 grains may prove fatal to a person with a normal heart. Death may linger for several days, or it may be sudden.

Identification. Excreted in urine as glycuronates or sulfates. (a) Conc. HCl; (b) aq. 5% sodium nitrite; (c) dil. NaOH; (d) alkaline beta-naphthol. Boil unknown with (a). Cool. Dilute with water. Add few drops (b) + (c) until litmus turns blue, then a few drops of (d). Red, turning mahogany on adding more (a) = acetanilid or phenacetin (azo-dye test).

Symptoms. Nausea and vomiting; cyanosis; slow, feeble pulse; subnormal temperature; mental sluggishness; stupor and collapse.

Treatment. Summon a physician. Keep patient warm and quiet, in recumbent position. Apply external heat. Wash the stomach with an emetic of mustard or 30 to 60 grains zinc sulfate in water; give oxygen for cyanosis, and artificial respiration if necessary. Give aromatic spirits of ammonia if conscious.

Other Poisons. See *Other Poisons* under **Acetanilid.**

PHENOL or **CARBOLIC ACID** (C_6H_5OH), hydroxybenzene, oxybenzene, phenylhydroxide, phenic acid, or phenylic acid is a

colorless to pinkish (on aging) solid, melting at 109° F.; if it contains water or cresols it may become a sticky liquid on warm days. Phenol is manufactured in enormous tonnages for phenolic plastics by the action of sodium hydroxide on benzene by alkaline hydrolysis of benzene monochloride at high pressures (Raschig process, used in the United States since 1940). It is the starting point for a great many organic syntheses, especially in the field of dyes; it is also an important laboratory reagent.

Liquid phenol is an 88 to 90% aqueous solution of phenol. **Camphorated phenol** contains 60% camphor, 30% phenol, and 3% liquid petrolatum, and is used as an antiseptic and local anesthetic.

Internally phenol has been used in diarrhea, and as an injection for anthrax and tetanus; its use to check stomach fermentation is open to question. Externally it is used as an antisepic on boils, venereal warts, and other growths; dilute solutions are used as a dressing for burns, stings, skin diseases, etc. It is sold, often mixed with chloride of lime, as a general disinfectant for toilets, drains, etc.

Phenol is not an acid, but exerts a powerful action and causes necrosis of the tissues with which it comes into contact. Although it is a most effective antiseptic, its terribly corrosive action on the tissues limits its use to applications where it will not contact the skin in any strong concentrations. Wet dressings containing phenol are especially dangerous, particularly to infants who absorb the poison rapidly. Since phenol has local anesthetic action, serious burns can occur before the patient is aware.

Normal dose is 1 grain or 0.06 gram. Eight to 15 g. may be considered a fatal dose, although recovery has followed ingestion of more than 3 times this amount; and death from $\frac{1}{10}$ the stated fatal dose.

Identification. Strong odor of phenol from breath or vomitus. *Test 1.* (a) Dissolve 5 g. mercury in 5 cc. fuming nitric acid. Dilute with 10 cc. water. After 24 hours pour off the clear upper liquid and use (Millon's reagent). Add few drops (a) to 1 cc. aq. unknown, and heat. Red = cresols and phenols. *Test 2.* (b) Ether; (c) bromine water. Extract unknown with (b); add few drops (c). White to yellowish precipitate of tribromphenol = phenol (Glaister's

test). *Test 3.* (d) Dilute neutral aq. $FeCl_3$. Add few drops (d) to 2 cc. unknown solution. Shake. Violet = phenols.

Symptoms. Burns, whitish in color, appear on the lips and mouth; pain in the throat and stomach; nausea and vomiting; headache, dizziness, drowsiness and depression, collapse; cold, moist skin; shallow breathing, and cyanosis. If a large amount of carbolic acid has been taken, the patient becomes unconscious and dies in a few minutes from paralysis of the heart and respiration. The characteristic odor of phenol is present.

Treatment. Summon a physician. **Do not give oils.** Administer the following as antidotes: an emetic followed by Epsom salts or Glauber's salts. Plenty of liquid should be given and the stomach should be washed out as rapidly as possible before the phenol has been absorbed. Use raw eggs and milk to protect the membranes. Keep the patient warm and quiet.

External Treatment. Summon a physician. Wash with alcohol or whiskey; and then immediately, before the alcoholic solution has been absorbed into the tissues, flush it off with much water.

PHOSPHORUS (P) is a nonmetallic element found in two common forms. One, the poisonous white or yellow phosphorus which is found in the form of white, waxy, translucent cylinders, oxidizes rapidly in the air, giving off fumes of the oxide; glows in the dark with a pale, yellow light; has the taste of garlic; and is usually kept under water. The other form of phosphorus is red, and is produced by heating yellow phosphorus in a closed vessel without air for thirty-six hours. Red phosphorus is not so toxic as white or yellow phosphorus; also the red variety is much less active chemically, is stable to light and air, and can be stored as a red powder without covering it with water.

White or yellow phosphorus is used in fireworks, rat poisons, smoke screens, in gas analysis, and in manufacturing phosphoric acid. Lucifer matches originally had heads of white phosphorus, sand, potassium chlorate, glue, etc., which was ignited by friction; but because of the poisonous nature of white phosphorus its use was prohibited by law, and a compound P_4S_3 mixed with potassium

chlorate is used today. The safety match, on the other hand, contains a tip of potassium chlorate or lead oxide, or potassium dichromate, antimony trisulfide, powdered glass, and glue; these matches catch fire when rubbed against the igniter surface, on the box, which contains a mixture of red phosphorus, antimony trisulfide, and glue.

Suicidal cases involving phosphorus are prevalent, but phosphorus has been used also in homicide, as well as having been taken accidentally by children and alcoholics. White phosphorus inflicts severe burns. The fatal dose is difficult to determine, but 3 grains is regarded as lethal. Death occurs in 1 to 4 days.

Identification. White phosphorus catches on fire when exposed to the air. Red phosphorus can be identified by burning a bit of it, dissolving the ash in water, and testing for orthophosphate as follows. (a) Aq. silver nitrate; (b) dil. HNO_3. To aq. unknown add 1 cc. (a) + 1 cc. (b). Yellow precipitate of Ag_3PO_4 = original unknown was phosphorus.

Symptoms. Nausea and vomiting, garlic taste, thirst, pain in the throat and stomach, diarrhea, headache, weakness, and collapse. The vomitus is luminous in the dark.

Treatment. Summon a physician. Emetic of mustard in water, or 3 grains of copper sulfate in water every 5 minutes until vomiting occurs, repeat emetic. Give whites of several eggs in water, and follow with a saline solution such as Epsom salts. Keep the victim warm and quiet. Avoid fats, oils, and milk.

External Treatment. Summon a physician. Use no oils or ointments. Apply a 2% copper sulfate solution to the burned area; this destroys the phosphorus. Keep the burned area under water, or preferably under 2% copper sulfate solution until the particles of phosphorus can be removed. If copper sulfate is not available, wash with a baking soda solution (tablespoonful in a glass of water); *keep it wet until a physician arrives.*

PICRIC ACID [$C_6H_2(NO_2)_3OH$], carbazotic, nitroxanthic, picronitric acid, T.N.P. or trinitrophenol, obtained by sulfonating phenol and treating the reaction mixture with nitric acid, forms yellow, odorless, very bitter crystals, which explode when heated (300°

C.), detonated, or by percussion. Ten to twenty per cent water is added for safety in transportation.

Picric acid is used in matches and explosives; as a dye intermediate; and in the leather industry; also in colored glass and electric batteries.

Medicinally, picric acid is used in ointments and dressings as an antiseptic for minor burns. **Butacein picrate,** a derivative, is applied as a 1% aqueous solution, or a 15% ointment.

Six grams has been taken without producing death.

Identification. Color of picric acid or butesein picrate will be deep yellow; they stain the skin yellow. (a) Aq. ammonium sulfide. Heat gently for 5 minutes the unknown water solution (**Care! Do not heat solid picric acid; it is explosive**) with 2 cc. (a). Within 5 minutes a red color of picramic acid develops = picric acid.

Symptoms. Mucous membranes and urine are deep yellow; skin irritated and deep yellow. Convulsions and collapse often occur following nausea and vomiting; pulse is weak.

Treatment. Summon a physician. Give the whites of several eggs; 1 tablespoonful of Epsom salts in a glass of water. Keep the victim warm and quiet.

POISON IVY, POISON OAK, POISON SUMAC. See chapter 6.

POTASSIUM BINOXALATE ($KHC_2O_4 \cdot H_2O$), potassium acid oxalate, salt of sorrel, or sal acetosella is used for removing ink stains, cleaning wood, scouring metals; in photography; and as a mordant in the dyeing industry.

Fatal dose varies between 1 and 3 dr. Usually when more than 1 ounce is retained death results regardless of proper treatment.

Identification. Same tests as for **Acid, Oxalic.**

Symptoms. Same as **Acid, Oxalic.**

Treatment. Summon a physician. Avoid baking soda and other alkali carbonates or alkalies. Give milk of magnesia or chalk, with large quantities of water; follow with an emetic of mustard in water;

repeat several times; follow with demulcent drinks of flour and water and the whites of several eggs. Use black coffee as a stimulant. Keep the patient warm and quiet.

POTASSIUM CARBONATE (K_2CO_3), pearl ash, potash, salt of tartar, or salt of wormwood sold as white, hydroscopic, odorless granules or powder. Industrially it is used in the manufacture of soft soap and hard glass; in the textile and leather industries; and for manufacturing potassium compounds.

Because potassium carbonate is so irritating, it is not used internally; rather it is applied externally as a 15% ointment or a 1% aqueous solution.

Normal dose is 15 grains or 1.0 gram; Potassium carbonate is an alkaline caustic, somewhat less powerful than potassium hydroxide.

Identification. Aq. solution turns litmus blue. *Test 1.* Flame test, page 17. Purplish tint to flame = potassium. Yellow only = sodium. *Test 2.* (a) Dil. HCl; (b) limewater; (c) small glass tube, size of pencil. Treat solid unknown with 1 cc. (a). Fizzing and gas off, probably CO_2. Hold drop of (b) in small tube just suspended above fizzing substance. Limewater (b) turns milky = carbonate.

Symptoms. Almost immediately there is pain in the mouth, throat, and stomach; nausea and vomiting; pallor; weak pulse and collapse. Usually death occurs within 24 hours.

Treatment. Summon a physician. Give harmless acids such as diluted vinegar, lemon juice, citric, or tartaric acid. Give freely. Empty stomach with an emetic if the solution is not too strong. Give demulcent drinks and raw eggs. Apply external heat. Keep the victim warm and quiet.

External Treatment. Summon a physician. Wash thoroughly with water, then with lemon juice or vinegar and again with water.

POTASSIUM CHLORATE ($KClO_3$) is manufactured by the electrolysis of a warm aqueous solution of potassium chloride, the products being allowed to mix. The same reaction occurs if chlorine is led into a warm solution of potassium hydroxide. Potassium

chlorate crystallizes from solution on cooling. It is found as crystalline powder, granules, and in drug stores as tablets; and its active oxidizing action makes it useful in matches, fireworks, explosives, and the printing and dyeing of cotton and wool black.

Potassium chlorate is used only externally, usually in a 3 to 5% solution as mouthwash or gargle for gingivitis and other throat disorders, but this use is waning.

Poisoning usually results when a potassium chlorate gargle is swallowed by mistake. The injury is to the kidneys and blood. Normal dose is 5 grains or 0.3 g. The fatal dose for an adult varies from 8 to 60 grams.

Identification. Dialyzed solution of stomach contents, add a little indigo sulfate and acidulate with dilute sulfuric acid. If chlorate is present the addition of sulfurous acid will discharge color. Aniline sulfate with sulfuric acid plus chlorate = blue color.

Symptoms. Pains in the abdomen, nausea and vomiting, diarrhea, jaundice, pallor, cyanosis, coma, and collapse.

Treatment. Summon a physician; he often relieves the condition by removing some of the blood from a vein and replacing it intravenously with normal salt solution. Give no stimulants. Wash out the stomach with an emetic, followed by demulcent drinks—flour in water, oatmeal gruel. Keep warm; apply external heat.

Other Poisons. Bromates, nitrates, and other chlorates same treatment as for **Potassium Chlorate.**

POTASSIUM HYDROXIDE (KOH), caustic potash, potassa, or sometimes incorrectly called potassium hydrate, is a powerful alkali similar to sodium hydroxide. Both are sold as white or slightly yellow lumps, rods, pellets, granules, or flakes, which absorb moisture from the air very rapidly, becoming damp. Potassium hydroxide has a multitude of uses in industry as in making soft and liquid soaps; for absorbing carbon dioxide from coke ovens; as a paint and varnish remover; in the printing trades, etc.

Potassium hydroxide has been used externally for cauterizing bites from rabid animals. A special paste containing equal parts of

limewater and potassium hydroxide is available for cauterizing and destroying surface growths.

An aqueous solution of potassium hydroxide is extremely caustic to human tissues. There have been a few cases of homicidal poisoning, but the majority are suicidal or accidental. Forty grains may cause death of an adult.

Identification. Solid potassium hydroxide if exposed to the air becomes very damp. Aq. KOH turns litmus blue, has a soapy feeling (wash hands immediately; do not wipe on clothing). Flame test, page 17. Yellow flame = sodium. Purplish flame = potassium.

Symptoms. Severe pains in the throat, mouth and stomach; nausea and vomiting; pallor; slow, weak pulse; burns on the lips and mouth; victim often dies from suffocation as a result of the passages swelling

Treatment. Summon a physician. Give harmless acids such as diluted vinegar, lemon juice, citric or tartaric acid. Give freely the whites of eggs. Care must be taken if a stomach tube is to be used to empty the stomach as it may puncture the weakened walls of the stomach. Give olive oil or heavy milk drinks; apply external heat. Keep quiet and warm.

External Treatment. Summon a physician. Wash thoroughly with water, then with lemon juice or vinegar, and again with water.

POTASSIUM PERMANGANATE ($KMnO_4$) or chameleon mineral is a deep purple, odorless, crystalline salt, manufactured by passing ozone into an aqueous solution of potassium manganate. Potassium permanganate is a powerful oxidizing agent used for bleaching fabrics, resins, fats and oils; for darkening leather and wood; and in analytical chemistry.

The effectiveness of potassium permanganate against snake bites is questioned by some authorities. It is taken internally to counteract poisoning by alkaloids, phosphorus, and cyanides. Externally a 0.5% solution is used as a wash for a number of ills: ulcers, abscesses, mouth diseases, etc.

Potassium permanganate can damage the membranes; also, the victim may die from collapse at any time after ingestion of a quan-

tity that does not have to be very large. Normal dose is 1 grain or 0.06 gram.

Identification. Potassium permanganate solutions are deep purple. (a) Dil. H_2SO_4; (b) 3% hydrogen peroxide (household). Dilute a crystal of the unknown until the solution is faint pink. To 2 cc. of this add 1 cc. (a); then add (b) up to 10 cc. Purple solution becomes colorless $MnSO_4$ = permanganate.

Symptoms. Nausea and vomiting; rapid, weak pulse; pallor; cold, clammy skin; and collapse.

Treatment. Summon a physician, who may administer stimulants. Empty the stomach with an emetic; give the whites of eggs, and follow with one tablespoonful of medicinal charcoal and water; keep quiet and apply external heat.

SEWER GAS. See Chapter 5.

SILVER NITRATE ($AgNO_3$) or lunar caustic, obtained by treating free silver with dilute nitric acid, forms colorless, odorless, transparent flaky crystals, which darken in the light. The commercial product is almost 100% pure, and is the one usually employed medicinally. Silver nitrate is used in the manufacture of other silver salts; in photography; for resilvering mirrors; in indelible inks and in hair dye; and as a reagent in analytical chemistry.

Silver nitrate pills are taken internally for stomach ulcers and intestinal disorders. Externally an extremely dilute solution is used for a variety of germicidal and antiseptic purposes; also to cauterize animal bites and as an astringent.

Many of the poisoning cases are largely due to absorption of silver nitrate in the blood, followed by deposition in the various tissues of the body. Normal dose is ⅙ grain or 0.01 gram. Thirty grains has proved fatal to an adult. Death occurs in a few hours to days.

Identification. *Test 1.* See spot tests, page 16. *Test 2* (a) Dil. HCl; (b) dil. HNO_3; (c) dil. NH_4OH. Treat unknown solution with few drops (a) + few drops (b). White precipitate of AgCl (silver chloride), dissolving in (c) to form soluble $Ag(NH_3)_2Cl$

diammine silver chloride = silver. *Test 3.* (d) Conc. H_2SO_4. Add 1 cc. (d) to solid unknown. Brown fumes of NO_2 = nitrate.

Symptoms. Pain in the throat and stomach; nausea and vomiting of black colored material; pallor; weak pulse; the lips may first have a grayish-white color then black; coma and collapse.

Treatment. Summon a physician. Give large amounts of common table salt in water, followed by an emetic of mustard in water; give demulcent drinks; apply external heat. Keep quiet and warm.

SILVER SALTS.

Identification. Test for silver as under **Silver Nitrate.** Test for cyanide as follows. (Note that treatment is different if cyanide is found present.) (a) Aq. 3% cupric acetate; (b) glacial acetic acid saturated with benzidine. Dip filter paper in a mixture of 15 cc. water + 1 cc. (a) + 5 cc. (b) and dry. Paper dipped into moistened unknown. Blue = cyanide.

Symptoms and Treatment. Same as for **Silver Nitrate,** except for silver cyanide. For silver cyanide the treatment is as follows: Summon a physician. Have patient swallow 1 tablespoonful of hydrogen peroxide (3%, household variety); use stimulants such as aromatic spirits of ammonia in water; have patient inhale ammonia; give artificial respiration if necessary.

SMOKES. See Chapter 5.

SNAKE VENOM. See Chapter 6.

SODIUM CARBONATE (Na_2CO_3), sal soda, Scotch soda, soda ash, soda crystals, washing soda, white acid, or trona (some of these names applying to the crude, natural products) is similar to potassium carbonate in uses, symptoms, and treatment. Average dose of the monohydrate ($Na_2CO_3 \cdot H_2O$) is only 4 grains or 0.25 gram.

Identification. Same tests as for **Potassium Carbonate,** except that the flame test for sodium is yellow.

Symptoms and Treatment. Same as for **Potassium Carbonate.**

SODIUM FLUORIDE (NaF), obtained by the reaction of sodium carbonate on hydrofluoric acid, forms colorless crystals and white powder. The common grade contains 1.5 to 3% sodium silicofluoride (Na_2SiF_6), and 94 to 97% NaF. It is used as an insecticide for roaches, fleas, ants, lice, etc.; also for preserving wood; and in mucilages and pastes. Sodium silicofluoride, Salufer, or sodium fluosilicate is similarly employed; also in moth-proofing, and in ceramic finishes.

Sodium fluoride is a deadly poison; and death has been caused by less than one grain.

Identification. *Test 1.* Flame test, page 17. Yellow flame = sodium. *Test 2.* Test for fluoride as described under **Acid, Hydrofluoric.**

Symptoms. Burning cramplike pains in the abdomen, muscular twitching at times, grayish-blue skin, pallor, weak pulse, convulsions.

Treatment. Summon a physician. Give large amounts of water followed by limewater, chalk, or weak calcium chloride solution; administer oxygen, apply artificial respiration if necessary. Keep quiet and warm.

External Treatment. Summon a physician. Wash with water and apply a paste of baking soda, milk of magnesia, or chalk and water.

SODIUM HYDROXIDE (NaOH), caustic soda, or lye, incorrectly called sodium hydrate, is sold as white, hydroscopic, odorless sticks, pellets, flakes, powder, granules, or lumps. It is manufactured by the electrolysis of molten table salt. Sodium hydroxide is a powerful alkali, and as such will "sweeten gasoline," that is, neutralize gum-forming acids; as an alkali, too, it reacts with fats to form soaps, and emulsifies grease in sinks and toilet bowls, for which purpose it is sold as a household cleanser (lye). Other uses of this most important alkali are in converting cellulose to alkali cellulose, the first step in making rayon; in the paper-pulp industry; and in the textile and rubber industries.

This caustic has been taken both by accident and as a means of committing suicide. In a few instances it has been used to disfigure and mutilate the body to make identification difficult. Thirty grains may cause death.

Identification. Same tests as described for **Potassium Hydroxide,** except that the flame test for sodium is yellow.

Symptoms. Sodium hydroxide produces symptoms almost immediately. Severe pains in the throat, mouth, and stomach; bloody vomitus; weak, rapid pulse; pallor; cold, clammy skin; collapse. The victim often dies as a result of suffocation from the swelling of the passages, or as a result of shock; usually within 24 hours.

Treatment. Summon a physician. Give large amounts of harmless acids such as diluted vinegar, lemon juice, citric or tartaric acid, also raw eggs and milk or other demulcent drinks. Keep warm and quiet and apply external heat. If the solution is not too strong the stomach may be emptied with a stomach tube by a physician but care must be exercised as the tube may penetrate the weakened walls of the stomach.

External Treatment. Wash with water, then with lemon juice or vinegar, and again with water. If in the eyes, wash with 5% boric acid solution.

SODIUM NITRITE ($NaNO_2$) is a white, odorless, crystalline salt obtained by heating sodium nitrate, or by treating an alkali with oxides of nitrogen. It is used industrially for manufacturing the diazo dyes, and as an analytical reagent.

Medicinally it is used internally for heart trouble, migraine, and epilepsy.

Identification. *Test 1.* Flame test, page 17. Yellow flame = sodium. *Test 2.* (a) Dil. H_2SO_4; (b) conc. H_2SO_4. The solid unknown is treated with 1 cc. (a). Another solid portion is treated with 1 cc. (b). Brown fumes of NO_2 with both (a) or (b) = nitrite. Brown fumes with (b) but not with (a) = nitrate. *Test 3.* (For other nitrites). Nitrites are found in the urine. (c) Aq. resourcinol; (d) conc. HCl; (e) dil. NH_4OH. Unknown + 1 cc. (c)

+ 1 cc. (d). Boil. Red, changed to violet by slight excess of (e) (**Care! Add drop by drop, while shaking.**) = nitrite.

Symptoms. (Notice that this is *nitrite;* for *nitrate* symptoms see **Potassium Chlorate**). Flushed face, violent then lessened heart action, dizziness and throbbing headache, muscular tremors, disturbed vision, nausea and vomiting, but rarely convulsions. Death occurs from respiratory failure, or sometimes from heart failure. Sodium nitrite causes the formation of a large amount of methemoglobin; this dilates the blood vessels causing a drop in blood pressure.

Treatment. Summon a physician. (Notice that this is *nitrite;* for *nitrate* treatment see **Potassium Chlorate**). Fresh air, recumbent position; give an emetic of mustard and water and repeat several times; give large quantities of black coffee; apply artificial respiration if necessary. Keep warm and quiet.

Other Poisons. Same treatment as for **Sodium Nitrite** is used for other nitrites and nitro-compounds (nitroglycerin, trinitrotoluene). Nitrocellulose is actually cellulose trinitrate.

SPIDER POISONS. See page 169.

STRYCHNINE ($C_{21}H_{22}O_2N_2$) or nux vomica is obtained from plants of the genus *Strychnos* and from the seed of *nux-vomica.* It is a highly poisonous alkaloid; its soluble salts are bitter. It is found as crystals and powder. In addition to being used in medicine, it is also used as an active ingredient in poisons for rats, mice, and other rodents; and for fur-bearing animals.

Cases of strychnine poisoning are common, most of them being suicidal, and a few homicidal. It is taken either by mouth or hypodermically. This drug produces its chief action on the nervous system. Normal dose of the sulfate is $\frac{1}{30}$ grain or .002 gram. One quarter grain of strychnine sulfate has produced death; on the other hand recovery has followed after 20 grains had been taken.

Identification. *Test 1.* (a) 1% ammonium vanadate in conc. H_2SO_4; (b) dil. ammonium hydroxide. Add 2 drops (a) to unknown solution. Blue changing to brilliant violet = strychnine. To

this add (b); changes to brilliant reddish violet = strychnine (Mandelin's test). *Test 2.* (c) Chloroform; (d) conc. H_2SO_4; (e) crystal of potassium dichromate. Dissolve unknown residue in (d). Drop a crystal into the mixture; shake gently. Colored streamers of blue, violet, red, and orange playing around crystal = strychnine. *Test 3.* (f) Solid manganese dioxide. Unknown + pinch of (f) + 1 cc. (d). Violet = strychnine.

Symptoms. The symptoms usually occur about 10 or 15 minutes after the poison has been ingested, but they may occur immediately, or after a delay of an hour. There is a sense of tightness in the chest; shuddering and then a violent spasm, characterized by stiffness of the neck, extension of the legs, a sardonic grin, staring eyes, and stiffened muscles of respiration; cyanosis; weak, rapid pulse; and dilated pupils.

Treatment. Summon a physician. Do not give emetics or use the stomach tube, as any effort to empty the stomach is likely to cause a fatal convulsion. Give 10 grains of potassium permanganate in a glass of water or 1 tablespoonful of medicinal charcoal. Have victim inhale amyl nitrite for collapse. Apply artificial respiration if necessary. If convulsions are violent, attempt to control them by administering inhalations of chloroform or ether. Give strong tea to relieve thirst. Keep the patient quiet and warm.

Other Poisons. Brucine, ignatia, nux vomica, tincture nux vomica, picrotoxin, same treatment as for **Strychnine.**

SULFANILAMID ($NH_2—C_6H_4—SO_2—NH_2$) and other **SULFA DRUGS,** white crystaline powders used against specific infections, should be taken *only under a physician's direction;* for improperly administered they irreparably damage the kidneys and destroy red blood corpuscles. Normal oral doses are (a) for sulfanilamid, 1 gram daily in divided doses for each 20 pounds of body weight up to 100 pounds; (b) for sulfapyridine, 2 grams initially, followed by ½ to 1 gram doses every 2 to 4 hours, total dose 16 to 25 grams; (c) for sulfathiozole, 4 grams initially, then 1 gram every 4 hours until temperature is normal for 72 hours. A child's dose is proportionately smaller.

Symptoms. Weakness, pallor, nausea, vomiting, weak pulse.

Treatment. Immediately stop use of the drug and summon a physician. Keep the victim warm and quiet.

THALLIUM SULFATE, found in rat poisons and insecticides, gives a green flame test. Less than ½ gram is fatal.

Symptoms. Usually first noticed 24 hours after poison is taken. Severe abdominal pain and vomiting; muscular weakness; purplish line on gums; breath foul; salivation; falling out of hair after a few days; perhaps swelling of the cheeks and eyelids. Cause of death is usually respiratory failure.

Treatment. Summon a physician. Give an emetic of mustard in water; demulcents; give stimulants of hot coffee; apply artificial respiration if necessary, and oxygen for cyanosis; keep body warm.

TURPENTINE ($C_{10}H_{16}$), resinous hydrocarbons from pine trees, is used in paints, polishes, etc. One teaspoonful has killed a child; six ounces killed an adult. Maximum working concentration (N.J. and Mass.) 200 ppm.

Identification. Odor on breath, clothing, vomitus. Mix 2 cc. unknown + 2 cc. ethyl alcohol + 1 cc. 1% vaniline in HCl. Shake. Pink turning blue-green from heat = turpentine.

Symptoms. Reddens skin; burning sensation in mouth; vomiting, colic, diarrhea, symptoms of shock.

Treatment. Summon a physician. Give mustard emetic; Epsom salts with much water; demulcents; heat body; black coffee stimulant.

WHITE LEAD [$Pb_3(OH)_2(CO_3)_2$], basic lead carbonate, ceruse, cerussa, flake lead, lead subcarbonate, or magistery of lead (sometimes incorrectly called lead carbonate) is made by the slow action of fermentation gases (acetic acid, water, and carbon dioxide) on buckles of lead (Dutch Boy White Lead brand process, which has been in operation 300 years); it is also manufactured by the action of carbon dioxide on lead spray in the presence of acetic acid and

superheated steam. White lead, a thick, creamy, heavy substance is used extensively in paints, putty, and cements.

White lead is used 10 to 30% in an ointment for skin diseases.

Fatal dose of white lead is 25 grams.

Identification. *Test 1.* See spot tests, page 16. *Test 2.* (a) Dil. HCl. Apply test for carbonate described under **Potassium Carbonate.** *Test 3.* Apply tests given under **Lead.**

Symptoms. A metallic taste in the mouth; throat dry and constricted; nausea and vomiting, diarrhea; leg and stomach cramps; a blue or black line on the gums; anemia and paralysis may occur.

Treatment. Summon a physician. Give 2 tablespoonfuls in ½ glass of water of Epsom salts (magnesium sulfate) or Glauber's salt (sodium sulfate). Follow with emetic of mustard in water. Keep patient warm with blankets and apply external heat. Give demulcent drinks, and stimulant. Give plenty of milk. For mild poisoning the patient should drink several quarts of milk.

ZINC (Zn) is a bluish-white, lustrous metal. It is found in the form of ingots, lumps, shot, sticks, granules, and powder. Some of its salts, such as the following, are poisonous.

ZINC ACETATE, is used to preserve wood, as a mordant in dyes, as a reagent, and in the manufacture of glazes for painting on porcelain. In medicine zinc acetate is used chiefly externally as an antiseptic, as a mouth spray and wash; and as an astringent. Injections of it are given in certain venereal diseases.

ZINC CHLORIDE, besides its use in medicine, finds very wide use in embalming materials, in solutions for preserving wood, in flux, etching, fire-proofing lumber, paper manufacture, deodorants, and disinfectants.

ZINC SULFATE, is used in medicines, as a mordant in calico dyeing, for preserving wood and skins, bleaching paper, and as a reagent in chemistry.

Other medically important zinc salts include **ZINC BROMIDE,** used in epilepsy; **ZINC CARBONATE,** used pure or 20% in ointment

as a mild astringent and protection on inflamed surfaces; **ZINC OXIDE**, 5 to 20% in ointments for burns, and as a dusting powder; and **ZINC STEARATE**, a soft white powder used in dusting powders for infants to prevent chafing.

Zinc salts have been swallowed accidentally, as well as with the intent to commit suicide. One and one-half ounces of zinc sulfate may be considered a fatal dose; 6 grams of zinc chloride has caused death.

Identification. See spot tests, page 16.

Symptoms. The victim will have a metallic taste, pain in the stomach, excessive salivation, vomitus of bloody material, purging, and collapse. Death may occur in a few hours, or within a few days.

Treatment. Summon a physician. Give medicinal charcoal (1 tablespoonful in water) or whites of eggs. Follow with sodium bicarbonate (1 tablespoonful in water). Give water freely, keep quiet and warm until the arrival of a physician.

Other Poisons. Cadmium salts same treatment as for **Zinc** salts.

CHAPTER 4

Emergency Information for Immediate Reference

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
ACETANILID Used to relieve neuralgia and muscular pains, reduce fevers, and in the manufacture of other medicinals.	Nausea and vomiting; slow, feeble pulse; subnormal temperature; mental sluggishness; cyanosis; stupor and collapse.	Summon a physician at once. Give an emetic of Epsom salts and water; repeat several times. Keep the victim warm and quiet; give a stimulant; apply artificial respiration if necessary, and administer oxygen if available.
ACID, ACETIC Used to make acetates, acetate plastics, acetate rayon; and as a solvent.	Skin is yellow where it comes in contact with the acid; burns on the lips and mouth; pain in the throat and stomach; difficulty in swallowing; nausea and vomiting; feeble pulse; diarrhea and collapse.	Summon a physician at once. Avoid stomach tube, emetics, or carbonates if the acid taken was concentrated. Give milk of magnesia and quantities of water or milk; follow with whites of eggs and milk. Keep the victim warm and quiet.
ACID, BORIC Used as eyewash, and in external ointments.	Nausea, diarrhea, headache, cold sweat, subnormal temperature, rash, collapse.	Summon a physician. Eliminate its use. Avoid baking soda. Give hot milk, emetic. Keep patient warm and quiet.
ACID, CARBOLIC	**SAME AS PHENOL**	**SAME AS PHENOL**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
ACID, HYDROCHLORIC Used extensively in industry and in the laboratory.	The lips and mouth on contact with the acid are usually white at first but later turn brown. Pain in the throat and stomach; difficulty in swallowing; nausea and vomiting; feeble pulse; diarrhea and collapse.	Summon a physician at once. Avoid stomach tube, emetics, or carbonates if the acid taken was concentrated. Give milk of magnesia and quantities of water or milk; follow with whites of eggs and milk. Keep the victim warm and quiet.
ACID, HYDROCYANIC Gas used as a fumigant for citrus trees, and in ships against rodents and vermin; salts used for case-hardening steel.	Possesses a peculiar peach blossom odor. Nausea and vomiting; feeble pulse; shallow breathing; dyspnea; cyanosis; convulsions and collapse.	Summon a physician at once. The treatment must be prompt. Have the victim inhale amyl nitrite for about 20 seconds. Give 2 tablespoonfuls of hydrogen peroxide and quantities of water, and repeat until the vomitus contains no odor of hydrocyanic acid. Apply artificial respiration if necessary. Keep the victim warm and quiet.
ACID, HYDROFLUORIC Gas or liquid used for etching glass; also used in the manufacture of fluorides.	**SAME AS ACETIC ACID.**	Summon a physician at once. The treatment must be prompt. Give weak solutions of limewater, followed with warm water, repeat several times. Give a stimulant and apply artificial respiration if necessary. Keep the victim warm and quiet.
ACID, NITRIC Used extensively as a nitrating agent in making explosives and fertilizers; also used as an oxidizing agent.	Stains on the lips and mouth are first white, later turning to a deep yellow. **OTHER SYMPTOMS SAME AS ACETIC ACID.**	**SAME AS ACETIC ACID.**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
ACID, OXALIC Used as an industrial bleach; and as an oxidation-reduction standard in the laboratory.	**SAME AS ACETIC ACID.**	**SAME AS ACETIC ACID.**
ACID, PHOSPHORIC Used in the manufacture of many phosphates; also, in the engraving and lithography trades.	**SAME AS ACETIC ACID.**	**SAME AS ACETIC ACID.**
ACID, SULFURIC The most widely used acid in all of chemical industry.	**SAME AS ACETIC ACID.**	**SAME AS ACETIC ACID.**
ACONITE [and ACONITINE] A source of alkaloids and one of the most deadly drugs known. Used to relieve pain locally, to lower blood pressure, and to reduce fever.	Salivation; a tingling sensation on the lips, mouth, and in the throat; nausea and vomiting, followed by collapse.	Summon a physician at once. Treat promptly; avoid emetics. Place the victim on his back with the feet elevated; give 10 to 30 grains tannic acid in water and follow with powdered charcoal; potassium permanganate (4 grains) in water. Apply cold to head, heat to body. Artificial respiration and oxygen if necessary.
ALCOHOL, ETHYL (grain) Used in beverages, medicines, extracts, etc.	The effects vary: some patients become quarrelsome, some sentimental, others fall asleep. Nausea and vomiting; the patient enters a stage of depression.	Summon a physician at once. Give an emetic of mustard and water; apply cold applications to the head; give a stimulant; keep the patient warm and quiet.
ALCOHOL, ISOPROPYL A substitute for rubbing alcohol.	**SAME AS ETHYL ALCOHOL.**	**SAME AS ETHYL ALCOHOL.**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
ALCOHOL, METHYL (wood) Used as solvent for shellacs and resins, in the manufacture of dyes and varnishes, as an antifreeze, a fuel, etc.	Initial symptoms like those for ethyl alcohol. Later, nausea and vomiting; dizziness; headache; dilated pupils; delirium and blindness.	Summon a physician at once. Give an emetic of mustard and water; repeat several times; follow with Epsom salts and stimulant. Keep the patient warm and quiet.
AMINOPYRINE Used to relieve headache, neuralgic pains, lower temperature in fever.	**SAME AS ACETANILID.**	**SAME AS ACETANILID.**
AMMONIUM HYDROXIDE (Ammonia Water) Used in cleaning and bleaching, removing stains; has a wide variety of uses about the home.	Burns on the lips and mouth, severe pains in the throat and stomach, diarrhea, weak pulse, pallor, and collapse.	Summon a physician at once. Give lemon or grapefruit juice, or vinegar; whites of eggs and milk. Keep the victim warm and quiet.
ANTIMONY TRICHLORIDE Used in medicine, in the manufacture of alloys, fireworks, etc.	Metallic taste in the mouth, pains in the abdomen, nausea and vomiting, the vomitus is blood stained, spasms of the fingers, arms and legs, followed by collapse.	Summon a physician at once. Give tannic acid or strong tea; give an emetic of mustard and water; repeat several times; follow with egg whites. Keep the patient warm and quiet.
ANTIMONY POTASSIUM TARTRATE Used as an emetic and expectorant.	Overdose causes symptoms similar to **ANTIMONY TRICHLORIDE.**	**SAME AS ANTIMONY TRICHLORIDE.**
ANTIPYRINE Uses are similar to those of **ACETANILID.**	**SAME AS ACETANILID.**	**SAME AS ACETANILID.**
APOMORPHINE Used as a cardiac depressant, emetic, sedative, and hypnotic.	Nausea and vomiting, pallor, flow of tears, exhaustion, and collapse.	Summon a physician at once. Allow the victim to inhale ammonia fumes, give an emetic of mustard

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
APOMORPHINE (Con't.)		and water, and a stimulant; apply ice to head; apply artificial respiration if necessary. Keep victim warm.
ARNICA Used as a counterirritant in sore muscles, bruises, sprains and strains.	Pain in the throat and stomach, nausea and vomiting, pallor, weak pulse, subnormal temperature.	Summon a physician at once. Give an emetic of mustard and water, medicinal charcoal, and repeat several times; follow with the whites of several eggs and milk; give a stimulant. Keep the patient warm and quiet.
ARSENIC Used in hardening metals, in alloys, rat poisons, flypaper, for trees and garden sprays, in dyes, etc.	Pain in the throat and stomach, nausea and vomiting, pallor, weak pulse, abdominal cramps, thirst, coma, convulsions, and collapse.	Summon a physician at once. Give an emetic of mustard and water, follow with Epsom salts, and repeat several times; give a wineglass of freshly prepared hydrated oxide of iron and magnesia and repeat the emetic; give castor oil and the whites of eggs and milk; follow with a stimulant. Keep the patient warm and quiet.
ATROPINE Used to relieve pain, and as a respiratory stimulant.	Excessive thirst and dryness of the mouth and throat, difficulty in swallowing; dry, flushed skin; dilated pupils, convulsions, coma, and collapse.	Summon a physician at once. Give an emetic of mustard and water; give ¼ teaspoonful tannic acid in water or strong tea; repeat the emetic; apply external heat; give a stimulant. Keep the patient warm and quiet.
BARBITAL Used as a sedative, and as a relief from pains.	Overdose causes subnormal temperature, low blood pressure, and cyanosis.	Summon a physician at once. Give an emetic of mustard and water; follow with a stimulant of strong black coffee. Keep the patient awake and warm.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
BARIUM ACETATE Used as a mordant for printing fabrics.	Nausea and vomiting, abdominal cramps, diarrhea, salivation, paralysis of the arms and legs, pallor, weak pulse.	Summon a physician at once. Give Epsom salts, and follow with an emetic of mustard and water. Keep the patient warm and quiet.
BARIUM CARBONATE Used in rat poisons, paints, enamels, etc.	**SAME AS BARIUM ACETATE.**	**SAME AS BARIUM ACETATE.**
BARIUM CHLORIDE Uses are similar to those of **BARIUM CARBONATE.**	**SAME AS BARIUM ACETATE.**	**SAME AS BARIUM ACETATE.**
BARIUM SULFIDE Used as a depilatory, in luminous paints, vulcanizing rubber, etc.	**SAME AS BARIUM ACETATE.**	**SAME AS BARIUM ACETATE.**
BARIUM SULFITE Has a variety of uses in industry.	**SAME AS BARIUM ACETATE.**	**SAME AS BARIUM ACETATE.**
BELLADONNA Its uses are similar to those of **ATROPINE.**	**SAME AS ATROPINE.**	**SAME AS ATROPINE.**
BISMUTH COMPOUNDS Used medicinally many times as bismuth dressings.	Nausea and vomiting; salivation; a blue line at the junction of the teeth and gums; swelling of the gums, tongue, and throat.	Summon a physician at once. Give an emetic of mustard and water; follow with the whites of eggs and milk; give a stimulant. Keep the patient warm and quiet.
CAFFEINE Its main use is as a stimulant.	Headache, restlessness, excitement, mental confusion, pain over the heart, inability to sleep, high blood pressure, strong pulse.	Summon a physician at once. The symptoms usually disappear after use of caffeine is discontinued.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
CALCIUM HYDROXIDE [and CALCIUM OXIDE] Used in plasters, cements, mortars, water paints, dehairing hides, and as an insecticide.	Pain in the throat and stomach, nausea and vomiting, thirst, pallor, weak pulse, collapse.	**SAME AS AMMONIUM HYDROXIDE.**
CAMPHOR PREPARATIONS Used for sprains, rheumatism, neuralgia, lumbago, etc.	The odor of camphor is on the breath, burning pain in the throat and stomach, pallor, weak pulse, poor vision, colic, headache, collapse.	Summon a physician at once. Give an emetic of mustard and water; allow the patient to inhale the fumes of diluted ammonia water; repeat emetic and give a stimulant of hot, black coffee. Give artificial respiration if necessary. Keep the patient warm and quiet.
CANTHARIDES or SPANISH FLY Medicinal hair tonic and vesicant. (Used externally.)	Burning pain in the mouth and throat, nausea and vomiting, cramps, diarrhea, weak pulse, delirium, collapse.	Summon a physician at once. Give an emetic of mustard and water, the whites of several eggs. Give large volumes of water with emetic; and repeat. Keep the patient warm and quiet.
CARBON DIOXIDE Used in beverages and fire extinguishers; as solid dry ice; and as a refrigerant.	Headache, unconsciousness, failure of respiration and circulation.	Summon a physician at once. Apply artificial respiration, and if available give oxygen with the use of an inhalator. Keep the patient warm and quiet.
CARBON MONOXIDE Present in automobile exhaust, and in some industrial gases.	Headache, bluish-red patches on body, unconsciousness, failure of respiration and circulation.	**SAME AS CARBON DIOXIDE.**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
CARBON TETRACHLORIDE Used in fire extinguishers, dry cleaning, as a solvent, etc.	Nausea and vomiting, headache, dizziness, pallor, weak pulse, subnormal temperature.	Summon a physician at once. Give an emetic of mustard and water; follow with Epsom salts and repeat; give a stimulant; apply artificial respiration if necessary. Keep the patient warm and quiet. Do not give oils or fats.
CHLORAL HYDRATE Used to induce sleep. Also known as "knockout-drops."	Drowsy, tired, cold hands and feet, nausea and vomiting, headache, stupor, heart failure.	Summon a physician at once. Give an emetic of mustard and water; give about 20 grains of tannic acid in water and repeat emetic; keep awake, warm, and quiet. Do not give alcohol.
CHLORINE [and CHLORINE WATER] Used to disinfect and deodorize; a bleach for wood, paper, pulp, cotton, and many other products.	Pain in the throat and stomach, nausea and vomiting, weak pulse, pallor, difficult breathing.	Summon a physician at once. Give an emetic of mustard and water and repeat; give the whites of eggs and milk. Allow the victim to sniff ammonia. Give a stimulant. Keep the patient warm and quiet.
CHLOROFORM Used as an anesthetic, analgesic, and antiseptic. Also as a solvent.	Slow, weak pulse becoming still slower; pallor, diluted pupils, and paralysis of the heart.	Summon a physician at once. Apply artificial respiration if necessary and if available administer oxygen from an inhalator. Keep the patient warm and quiet.
COCAINE Used to relieve pain.	Restlessness, nausea and vomiting, patient may be happy and talkative; pain in the abdomen, convulsions, coma.	Summon a physician at once. Allow the victim to sniff dilute ammonia water. Give medicinal charcoal, hot black coffee, and

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
COCAINE (Con't.)		artificial respiration if needed. Keep the patient warm and quiet.
CODEINE Used to lessen pain, calm nerves, and induce sleep.	Nausea and vomiting, weak pulse, pallor, cold, tired, coma, collapse.	Summon a physician at once. Give 10 grains potassium permanganate in pint of water; follow with an emetic of mustard and water; repeat. Apply ice to head and give a stimulant. Apply artificial respiration if necessary. Keep the patient warm, quiet and awake.
COPPER ACETATE or CUPRIC ACETATE Used in the manufacture of pigments and insecticides; in dyeing and printing fabrics; etc.	**SAME AS COPPER ACETOARSENITE.**	**SAME AS COPPER ACETOARSENITE.**
COPPER ACETOARSENITE Used as a pigment, an insecticide, and a wood preservative.	Nausea and vomiting, pallor, diarrhea, symptoms of collapse and heart failure.	Summon a physician at once. Give egg whites or milk abundantly, large quantities of water. Best antidote is potassium ferrocyanide (5-15 grains) in water.
COPPER ARSENITE or CUPRIC ARSENITE Its uses are similar to those of **COPPER ACETOARSENITE** and **CUPRIC ACETATE.**	**SAME AS COPPER ACETOARSENITE.**	**SAME AS COPPER ACETOARSENITE.**
COPPER SULFATE or CUPRIC SULFATE. Its uses are similar to those of **COPPER ACETOARSENITE, CUPRIC ACETATE,** and **CUPRIC ARSENITE.**	**SAME AS COPPER ACETOARSENITE.**	**SAME AS COPPER ACETOARSENITE.**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
CREOLIN. See Cresols. Water emulsion of phenolics (cresols).	**SAME AS PHENOL.**	**SAME AS PHENOL.**
CREOSOTE. (See Cresols.	**SAME AS PHENOL.**	**SAME AS PHENOL.**
CRESOLS Used as disinfectants, germicides, and deodorants.	**SAME AS PHENOL.**	**SAME AS PHENOL.**
CROTON OIL Used to induce patients to take medicines when not willing, or able to swallow.	Nausea and vomiting, weak pulse, pallor, severe griping pains, violent purging, and collapse.	Summon a physician at once. Give an emetic of mustard and water, using quantities of water; follow with whites of eggs and milk, and a stimulant. Keep the patient warm and quiet.
CYANIDES Potassium, sodium and other salts.	**SAME AS ACID, HYDROCYANIC.**	**SAME AS ACID, HYDROCYANIC.**
DIGITALIS Used as a cardiac stimulant.	Nausea and vomiting, pallor, diarrhea, pain in the abdomen, weak pulse, poor vision, headache, dizziness, and collapse.	Summon a physician at once. Give an emetic of mustard and water, 60 grains of tannic acid in a pint of water; repeat emetic; apply artificial respiration if necessary. Keep patient warm and quiet.
ERGOT Used to check bleeding from uterus or to contract the uterus in childbirth.	Nausea and vomiting, cramplike pains low in the abdomen, diarrhea, itching and tingling of the skin, weak pulse, heart pains, shortness of breath, muscle spasms and possibly convulsions, and coma before death.	Summon a physician at once. Give an emetic of mustard and water, medicinal charcoal, castor oil, a stimulant. Keep the patient warm and quiet.
ETHER Used as a general anesthetic, a stimulant, a solvent, cleaning agent, etc.	**SAME AS CHLOROFORM.**	**SAME AS CHLOROFORM.**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
FORMALDEHYDE Used in embalming fluids, for hardening films, as a germicide, antiseptic, and deodorant.	Nausea and vomiting, clammy skin, weak pulse, pallor, burning in the mouth and throat, and collapse.	Summon a physician at once. Give aromatic spirits of ammonia in water, medicinal charcoal; follow with the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
GASOLINE Has many uses, the greatest being as a fuel.	Nausea and vomiting, headache, giddiness, affected vision; in general the symptoms greatly resembles drunkenness.	Summon a physician at once. Give an emetic of mustard and water; follow with Epsom salts; repeat the emetic; give a stimulant of black coffee. Apply artificial respiration if needed. Keep the patient warm and quiet.
HEROIN Used as a sedative and antispasmotic.	**SAME AS CODEINE.**	**SAME AS CODEINE.**
HYDROGEN PEROXIDE Used in medicine and also as a bleaching agent, an oxidizing agent, an antiseptic, and a catalyst.	Nausea and vomiting, pallor, weak pulse.	Summon a physician at once. Give an emetic of mustard and water; follow with Epsom salts; repeat the emetic, and a stimulant. Keep the patient warm and quiet.
HYDROGEN SULFIDE Used as a reducing agent.	Headache, nausea and vomiting, greenish face, weak pulse, coma, and respiratory failure.	Summon a physician at once. Apply artificial respiration; if an inhalator is available allow the patient to inhale the oxygen from it; also allow the patient to inhale chlorine fumes. Keep the patient warm and quiet.
IODINE Used in medicines, also as an antiseptic.	Metallic taste in the mouth; nausea and vomiting; pallor; sense of	Summon a physician at once. Give the whites of several eggs and milk, an

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
IODINE (Con't.)	heat in the mouth, throat and stomach; dilated pupils; cyanosis; convulsions; and collapse.	emetic of mustard and water, and repeat several times. Keep the patient warm and quiet.
IODOFORM Used as an antiseptic.	Headache; rapid, weak pulse; pallor; dizziness; may attempt suicide; collapse.	Summon a physician at once. Give baking soda and water, follow with an emetic of mustard and water and repeat; give a stimulant. Keep the patient warm and quiet.
LEAD SALTS Have many uses in industry.	Headache; metallic taste in mouth and throat; nausea and vomiting; blue line on the gums; constricted throat; diarrhea, anemia, and paralysis may appear.	Summon a physician at once. Give an emetic of mustard and water; follow with Epsom salts and repeat emetic; give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
LYE or SODIUM HYDROXIDE Used extensively in industry and in the home.	**SAME AS AMMONIUM HYDROXIDE.**	**SAME AS AMMONIUM HYDROXIDE.**
LYSOFORM Is a mixture of cresols and formaldehyde.	**SAME AS PHENOL.**	**SAME AS PHENOL.**
LYSOL Is cresol suspended in a soap.	**SAME AS PHENOL.**	**SAME AS PHENOL.**
MERCURIC OXIDE, RED Used in medicine and industry.	**SAME AS MERCURY BICHLORIDE.**	**SAME AS MERCURY BICHLORIDE.**
MERCURIC OXIDE, YELLOW Used in medicines and industry.	**SAME AS MERCURY BICHLORIDE.**	**SAME AS MERCURY BICHLORIDE.**
MERCUROUS CHLORIDE A powerful antiseptic.	**SAME AS MERCURY BICHLORIDE.**	**SAME AS MERCURY BICHLORIDE.**

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
MERCURY BICHLORIDE Has many uses in medicine. Also used in various industries.	Metallic taste in the mouth; nausea and vomiting; thirst; diarrhea; weak pulse; slow, shallow breathing; and collapse.	Summon a physician at once. Give an emetic of mustard and water and repeat several times using quantities of water, follow with the whites of eggs, and a stimulant. Keep the patient warm and quiet. (Preferred antidote is sodium formaldehyde sulfoxylate given in accordance with directions acpanying the drug.)
MORPHINE Used to lessen pain, calm nerves, induce sleep, etc.	**SAME AS CODEINE.**	**SAME AS CODEINE.**
MUSHROOM POISONING Toadstools.	Violent abdominal pains; nausea and vomiting; diarrhea; slow, weak pulse; jaundice; and collapse.	Summon a physician at once. Give an emetic of mustard and water; follow with a large dose of Epsom salts; repeat procedure; give a stimulant. Keep the patient warm and quiet.
NAPHTHALENE In moth balls; in dye, resin, and plastic industries.	Restlessness, depression, twitching, the urine is brown to black, weak pulse, pallor, coma, and snoring.	Summon a physician at once. Give an emetic of mustard and water; repeat several times; follow with milk or oatmeal and stimulant. Keep the patient warm and quiet.
NICOTINE Used as a plant spray.	Pallor, tremors, palpitations, headaches, dizziness, respiratory paralysis, and coma.	Summon a physician at once. Give tannic acid and medicinal charcoal, and a stimulant; apply ice to the head. Keep the patient warm and quiet.
NITROUS FUMES— See Chapter 5		

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
OPIUM Used to lessen pain, calm nerves, induce sleep, etc.	**SAME AS CODEINE.**	**SAME AS CODEINE.**
PHENACETIN Uses are similar to those of **ACETANILID**	**SAME AS ACETANILID.**	**SAME AS ACETANILID.**
PHENOL Used as an antiseptic, disinfectant, and deodorant.	Whitish burns on the mouth, pains in the throat and stomach, nausea and vomiting, dizziness, pallor, weak pulse, shallow breathing, depression, and unconsciousness.	Summon a physician at once. Give an emetic of mustard and water; use quantities of water and repeat the emetic several times; follow with large glass of Epsom salts; give the whites of several eggs and milk. Keep the patient warm and quiet. Do not give oils.
PHOSPHORUS, WHITE Used in fireworks, poisons for mice, rats, etc.	Nausea and vomiting, a garlic taste, headache, pallor, weak pulse, diarrhea, vomitus luminous in dark, collapse.	Summon a physician at once. Give copper sulfate (3 grains) every 5 minutes until vomiting occurs; give an emetic of mustard and water and repeat; follow with the whites of eggs in water. Keep the patient warm and quiet. Give no oils, fats or milk.
PHOSPHORUS, RED Its uses are similar to those of **WHITE PHOSPHORUS.**	**SAME AS WHITE PHOSPHORUS.**	Summon a physician at once. Give an emetic of mustard and water and repeat several times; follow with the whites of several eggs in water. Keep the patient warm and quiet.
PICRIC ACID Used in matches, explosives, in the leather industry, and in the manufacture of textile mordant.	Skin yellow where it contacts the acid, weak pulse, pallor, nausea and vomiting convulsions, and collapse.	Summon a physician at once. This is not an acid; therefore do not give the general treatment for acids. Give the whites of several eggs, and large

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
PICRIC ACID (Con't.)		quantities of Epsom salts. Keep the patient warm and quiet.
POISON IVY, POISON OAK, POISON SUMAC See Chapter 6		
POTASSIUM BINOXALATE or **SALT OF SORREL** Used as an ink and iron-rust remover, and as a mordant in dyeing.	**SAME AS OXALIC ACID.**	**SAME AS OXALIC ACID.**
POTASSIUM CARBONATE Used in the manufacture of soap, glass, and pottery.	Nausea and vomiting, pain in the throat and stomach, weak pulse, pallor, collapse.	Summon a physician at once. Give lemon juice and emetic of mustard and water and repeat several times; give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
POTASSIUM CHLORATE Used in the manufacture of matches, fireworks, etc.	Nausea and vomiting, pain in the throat and stomach, diarrhea, jaundice, weak pulse, pallor, cyanosis, coma, and collapse.	Summon a physician at once. Give no stimulants. Give an emetic of mustard and water and repeat several times; follow with the whites of several eggs. Keep the patient warm and quiet.
POTASSIUM HYDROXIDE Used in the manufacture of soap, as paint remover, in printing inks, etc.	**SAME AS AMMONIA WATER.**	**SAME AS AMMONIA WATER.**
POTASSIUM PERMANGANATE Used for bleaching resins, waxes, oils, fats, etc.	Nausea and vomiting; rapid, weak pulse; pallor; cold, clammy skin; collapse.	Summon a physician at once. Give an emetic of mustard and water, repeat emetic, follow with medicinal charcoal and the

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
POTASSIUM PERMANGANATE (Con't.)		whites of several eggs in milk, and a stimulant. Keep the patient warm and quiet.
SEWER GAS See Chapter 5.		
SILVER NITRATE Used in the manufacture of indelible inks, silver salts, for resilvering mirrors, etc.	Nausea and vomiting, the vomitus being black, pain in the throat and stomach, weak pulse, pallor, coma and collapse.	Summon a physician at once. Give large quantities of salt water; follow with an emetic of mustard and water and repeat; give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
SILVER SALTS Its uses are great in industry.	**SAME AS SILVER NITRATE.**	Summon a physician at once. For **SILVER CYANIDE:** give tablespoonful hydrogen peroxide (3%); whiskey or ammonia in water as a stimulant. For other Silver Salts: **SAME AS SILVER NITRATE.** Follow both with emetic of mustard and water, the whites of eggs, and a stimulant. Keep the patient warm and quiet.
SMOKES See Chapter 5.		
SNAKE VENOM See Chapter 6. Resulting from the bite of the rattlesnake, the copperhead, or the cottonmouth moccasin.	A sharp burning pain followed by discoloration and swelling; two fang marks usually present; pallor; cold, clammy skin.	Summon a physician at once. Immediately apply a restriction band a few inches above the bite (release every 20 minutes for a couple of seconds), Make X-shaped cuts ½ inch deep and allow the blood to flow; also apply suction. Use no stimulants; do not attempt to

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
SNAKE VENOM (Con't.)		cauterize the wound; do not apply potassium permanganate. Keep the patient warm and quiet.
SODIUM CARBONATE	**SAME AS POTASSIUM CARBONATE.**	**SAME AS POTASSIUM CARBONATE.**
SODIUM FLUORIDE Used as an insecticide.	Burning cramplike pains in the abdomen, grayish-blue skin, weak pulse, pallor, and collapse.	Summon a physician at once. Give large quantities of water, and lime water and repeat several times; give stimulant and if necessary administer artificial respiration. Keep the patient warm and quiet.
SODIUM HYDROXIDE Used in the manufacture of paper and soap, in oil refining, and numerous other industries.	**SAME AS AMMONIUM HYDROXIDE.**	**SAME AS AMMONIUM HYDROXIDE.**
SODIUM NITRATE Used in the manufacture of diazo dyes.	Nausea and vomiting, flushed face, violent then lessened heart action, dilated pupils, pallor, and collapse.	Summon a physician at once. Allow the patient to breathe fresh air; give an emetic of mustard and water and repeat; give a stimulant and alternate douches of hot and cold water. Keep the patient warm and quiet.
SPIDER POISONS See Chapter 6.		
STRYCHNINE Used in medicine; also in rat poisons, etc.	Dilated pupils, terrified expression, fixed grin, weak and feeble pulse, body arches so that it rests on the head and heels, then relaxes, the body shudders, and collapse results.	Summon a physician at once. Do not use emetics or stomach tube. Give 10 grains potassium permanganate in a glass of water, and medicinal charcoal; allow the victim to inhale ether or amyl nitrite. Give strong tea and apply artificial respiration if necessary. Keep the patient warm and quiet.

POISONS AND USES	SYMPTOMS	EMERGENCY TREATMENT
THALLIUM SALTS Used in rat poisons, and ant powders.	Severe abdominal pains; purplish gums, foul breath, salivation, respiratory failure.	Summon a physician. Give emetics, hot coffee, artificial respiration. Keep patient warm.
TURPENTINE Used in many processes.	Characteristic odor is present, burning sensation in the throat and stomach, nausea and vomiting, skin rash, colic, diarrhea, weak pulse, convulsions, and collapse.	Summon a physician at once. Give an emetic of mustard and water, follow with a large glass of Epsom salts and repeat, give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
WHITE LEAD Used in putty, pigments, etc.	Metallic taste, dry throat, nausea and vomiting, diarrhea, leg cramps, blue line on gums, pallor, weak pulse, anemia, and paralysis.	Summon a physician at once. Give large drink of Epsom salts; follow with an emetic of mustard and water and repeat; give the whites of several eggs and milk, and a stimulant. Keep the patient warm and quiet.
ZINC ACETATE Used in medicine and many industries.	Metallic taste, pain in the stomach, salivation, nausea and vomiting, the vomitus of bloody material, purging, pallor, and collapse.	**SAME AS COPPER ACETOARSENITE.**
ZINC CHLORIDE Its uses are similar to those of **ZINC ACETATE.**	**SAME AS ZINC ACETATE.**	**SAME AS COPPER ACETOARSENITE.**
ZINC SULFATE Its uses are also similar to those of **ZINC ACETATE.**	**SAME AS ZINC ACETATE.**	**SAME AS COPPER ACETOARSENITE.**

CHAPTER 5

Industrial Hazards

Industry is confronted with many hazards, so that disregard of safety in the plant is particularly dangerous. Six major types of accidents and injuries are encountered:

Asphyxiation	Explosion
Chemical burns	Fire
Dermatitis	Poisoning

Some chemicals may cause several of these six accidents or injuries, and are hazards while in use, in storage, and during transportation.

Hazard Factors. With the rapid advances in chemical fields today comes a responsibility for handling different, unfamiliar chemicals; the usual well-known solvents and chemicals are being replaced by new, strange substitutes, whose dangerous properties are sometimes little known to the chemical worker. If casualties and accidents are to be kept in check, serious consideration must be given to these new hazards, by the management as well as by the employee.

There are a number of important factors that tend to influence the extent of industrial poisonings; some of these factors concern the employee, while others involve the conditions under which the work is performed. A consideration of each of these factors follows.

Alcohol. Most safety directors agree that alcoholics do definitely lower the standards of plant safety records, and also have a greater susceptibility to certain poisons.

Atmospheric Conditions. Air hygiene is one of the most important factors in the health of the employee. The temperature, cleanliness of the air and humidity play an important part in healthy working conditions. When toxic substances are removed at or near their point of origin, it is obvious that the chances of poisoning is minimized.

Food. It is an established fact that poison is absorbed more rapidly when the stomach is empty than when full. The English, for instance, years ago recognizing that food in the stomach was one of the best preventive methods for avoiding poisoning, supplied cocoa and milk to workers in plants where the danger from absorption of certain poisons was high.

Heat. Heat increases the action of chemicals, and the speed with which they are absorbed. Heat and humidity also lower the individual's resistance and increase the amount of vapors absorbed by the body.

Hours. It is obvious that long hours on the job increase the risk of poisoning. This is true both because the dose of poison per day is increased, and the opportunity of eliminating it at night is decreased. A worker will, of course, absorb more poison in twelve hours than he would in eight hours; and during the subsequent off-work period, he would eliminate less in twelve hours than in sixteen hours.

Sex. Studies have shown that women employed in certain industries not only succumb more rapidly, but also suffer more severely from the effects, than do men.

In the past few years much of the danger involved in the chemical industry has been eliminated as a result of engineering improvements, good management, and safe practices.

Poisonous Chemicals in Industry

In preceding chapters we discussed those poisons that are generally swallowed by accident or with suicidal intent, or given for homicidal purposes. Here we discuss poisoning of a different kind. When persons are poisoned on the job, it is usually by inhalation or absorption. Many times there are no signs of poisoning for days and weeks, until the concentration of poison in the body has reached the tolerance limit. From this time on chronic symptoms appear, and medical

TABLE 5. CHEMICALS, THEIR POTENTIAL HAZARD

Chemical	*Inflammable*				*Toxic*		
	Flashpoint °F.	Underwriters' Lab. Classification	Explosive	Special (see note)	Ingestion	Inhalation	Skin Contact
Acetic acid	115	.	.	.	X	.	X
Acetone	0	90	X	.	X	X	X
Amyl acetate	77	55-60	.	.	X	X	.
Amyl alcohol	100	40	X	.	X	X	.
Aniline	168	.	.	.	X	X	X
Benzene (benzol)	12	.	X	.	X	X	.
Bromine	—	.	.	.	X	X	X
Butyl acetate	72	.	X	.	X	X	.
Butyl alcohol	82	40	X	.	X	X	.
Carbon disulfide	—22	110	X	.	X	X	X
Carbon tetrachloride	—	0	.	.	X	X	.
Cellosolve	104	.	X	.	X	.	.
Cellosolve acetate	124	.	X	.	X	.	.
Chloroform	—	.	.	.	X	X	.
Chromic acid	—	.	.	A	X	X	X
Cresol	178	.	.	.	X	X	X
Dichlorethylene	43	.	X	.	X	X	.
Ethyl acetate	24	.	X	.	X	.	.
Ethyl alcohol	55	70	X	.	X	X	.
Ethyl chloride	—58	.	X	.	X	X	.
Ethyl ether	—49	100	X	.	X	X	.
Ethylene dichloride	56	60-70	X	.	X	X	.
Formic acid	130	.	X	.	X	X	X
Glycerine	320	.	.	.	.	.	.
Hexane	—15	.	X	.	X	.	.
Hydrochloric acid (muriatic)	—	.	X	.	X	X	X
Hydrocyanic acid	0	.	X	.	X	X	X
Hydrofluoric acid	—	.	.	.	X	X	X
Hydrogen peroxide	—	.	.	A	X	.	X
Mercury	—	.	.	.	X	X	X
Methyl alcohol	52	.	X	.	X	X	.
Methylene chloride	—	.	.	.	X	X	.
Nitrobenzene	190	.	.	.	X	X	X
Nitric acid	—	.	.	A	X	X	X
Pentachlorethane	—	.	.	.	X	X	.
Sulfuric acid	—	.	.	A	X	X	X
Tetrachlorethane	—	.	.	.	X	X	.
Tetrachlorethylene (Perchlorethylene)	—	0	.	.	X	X	.
Toluol	40	75-80	X	.	X	X	.
Water	—	.	.	.	.	.	.
Xylol	63	.	X	.	X	X	.

Key to above: X = considered a hazard. . = not a hazard. A = nonflammable, but may cause fire if it comes in contact with organic substances.

References: National Fire Protection Association; U. S. Department of Labor; Associated Factory Mutual Fire Insurance Company.

attention is necessary. **For such chronic industrial poisoning, very little should be done until the physician arrives. Call him at once.**

While it is obviously impossible to describe here all of the industrial chemicals that are the products of our modern civilization, descriptions will be given for some one hundred and fifty common industrial chemicals. The chemicals and their toxic doses are given in subsequent pages and have been taken from a number of publications, particularly M. B. Jacobs: *Analytical Chemistry of Industrial Poisons, Hazards, and Solvents,* Second Revised Reprint, Interscience Publishers, Inc. (New York City), 1944; this volume is especially recommended for its critical analysis of the literature in the field, and for its many references to original papers.*

Chemicals and Industries Where Used. The reader's attention is directed to 127 through 129 where the various chemicals discussed in this chapter are listed. The industries in which these chemicals are used are described briefly under each chemical. For various names for the same chemical, see the index.

Nature of Poisoning. The poison may be: (1) inhaled as a vapor, (2) absorbed through the skin, or (3) swallowed. If the worker is exposed to highly poisonous concentrations of chemicals in the air, or spills on his skin a liquid that is rapidly absorbed through the skin, symptoms of *acute poisoning* result. If the worker is exposed to low concentrations of vapor, or intermittent sprays of liquids, which can be absorbed through the skin, and the poison is of the type that accumulates in the body faster than it can be excreted, *chronic poisoning* results. Chronic poisoning may not be noticeable for days or months, as for example in lead poisoning, or poisoning by radioactive compounds.

The chemicals may be corrosive, toxic, or irritant *liquids.* They may be obstructive, toxic, or irritant *dusts.* They may be *gases, fumes, or vapors* whose poisonous action is asphyxiant, toxic, or irritant.

* Dangerous concentrations of industrial vapors are quoted, in general, from Jacobs, *Analytical Chemistry of Industrial Poisons, Hazards, and Solvents.* The authors are indebted to Dr. Jacobs, and to the Interscience Publishers, Inc. for permission to quote his figures.

The poisons may affect: (1) the circulatory system or blood stream; (2) such organs as the lungs, stomach, liver, kidneys, and so on; (3) the nervous system; or (4) the skin and mucous membranes.

Preventive Measures. Most plant safety directors agree to the following suggestions for lowering the number of poisoning cases by chemicals.

Personal Cleanliness. This is important in the control of most diseases and industrial poisonings, and should play a prominent part in any safety program. Frequent washing with soap and water, laundering of clothes, and clean habits are first-line defenses against the hazards of poisoning. The employer should provide proper facilities for the employee. Many employers in their attempt to help the worker have installed clean washrooms, showers, hot and cold water, good soaps, clean towels, sanitary drinking fountains, individual lockers, and slippers for walking to and from showers.

Protective Equipment. By avoiding contact with irritant materials much of the poisoning can be eliminated. Some of the equipment necessary in this field of safety include gloves, aprons, boots, gauntlets, masks, caps, respirators, and so on. All equipment should be cleaned often, and tested for efficiency.

Protective Creams. These creams are applied to the hands, arms, and other exposed skin surfaces before exposure. The protective film acts as a barrier against harmful, irritating substances.

Engineering. Protection through proper and intelligent engineering will aid greatly toward eliminating vapors, dusts, fumes, and solutions from reaching the worker.

The above mentioned aids will do much toward controlling industrial poisoning, especially if the worker will use his own good judgment and care. All the safety rules and devices in use today are without value if the worker does not do his part in abiding by the carefully worked out safety precautions.

Specific Chemical Action. Certain types of chemicals are known to act specifically on certain portions of the body. The following are a few substances listed under the organs and systems they affect.

General Systemic Poisoning

arsenic
carbon disulfide
lead
mercury
methyl alcohol

Circulatory System

aniline
arsenic
benzene
carbon monoxide
dinitrobenzene
lead
mercury
nitrobenzene
trinitrotoluene
vanadium

Respiratory System

ammonia
chlorine
cobalt arsenide
hydrogen sulfide
nitrous fumes
silica
sulfur dioxide

Gastro-Intestinal System

antimony
arsenic
benzol
cadmium
chlorinated hydrocarbons
cyanides
lead
mercury
nitroamido compounds
tetrachloroethane
zinc

Skin

actinic rays
anthracene
benzine
benzol
chromates
formaldehyde
hexamethylenetetramine
paraphenylendiamine
turpentine
tar
X-rays
zinc chloride

Skeleton and Joints

arsenic
lead
mercury
mesothorium
phosphorus acids (on teeth)
radium

Genito-Urinary System

aniline
arsenic
benzol
beta-naphthylamine
ether
mercury
nitroglycerin
paranitraniline
phenol
turpentine
vanadium
X-rays

Organs of Special Sense

arsenic
benzol
carbon disulfide
hydrocyanic acid
hydrogen sulfide
lead
manganese
mercury
methyl alcohol
turpentine

Brain and Nervous System

arsenic
benzine
carbon disulfide
cyanide
dimethyl sulfate
ether
lead
manganese
methyl alcohol
naphtha
nitroglycerin
phenol
trichloroethylene

Toxic Concentrations. Let us suppose that a workman has broken a bottle containing a pound of benzene in a room 10 x 10 x 10 feet. An hour later he discovers that the ventilators are not working, and wishes to know whether he is likely to be poisoned from the exposure. The data given in the following pages enable him to determine this.

He has been working in a concentration of 16 avoirdupois oz. of benzene per 1000 cubic feet. Under Benzene we find that this very exposure may produce serious illness. He should therefore summon a physician.

Two other expressions are more often used by the chemist than the oz. per cu. ft. just given. They are (1) parts by volume of the poisonous vapor per million parts of poisonous air; this is abbreviated to ppm.; and (2) the milligrams of poison per liter of air.

In the descriptions that follow, toxic concentrations are given wherever such information is available in the literature, as summarized in Jacob's book. The expressions may be converted from one to another by use of the following, in which M is the molecular weight of the poison:

$$\text{ppm.} = \frac{24450 \times (\text{mg./liter})}{M}$$

$$\text{mg./liter} = \frac{\text{ppm.} \times M}{24450}$$

$$\text{mg./liter} = \text{avoirdupois oz./1000 cu. ft.}$$

For most poisons the following expression holds true:

Extent of poisoning = exposure time × concentration of poison; that is an exposure to 50 ppm. of gas for 30 minutes produces approximately the same poisoning effect as a 60-minute exposure to 25 ppm.

Allowable Concentrations can be decided only by extensive tests; moreover a concentration that may be *injurious* to one person may be *tolerated* by another individual. Concentrations allowed for safe working conditions are stated in Table 6; these figures have been obtained from the State of Massachusetts and the New Jersey Department of Health. Naturally the toxic concentration is subject to the idiosyncracies of the person exposed.

TABLE 6. ALLOWABLE CONCENTRATIONS OF TOXIC MATERIALS (1945)

GASES AND VAPORS	*MAXIMUM ALLOWABLE CONCENTRATION*	
Acrolein	1 ppm.	N. J.
Acrylonitrile	20 ppm.*	N. J.
Ammonia	100 ppm.	N. J. and Mass.
Amyl acetate	400 ppm.*	N. J. and Mass.
Aniline	5 ppm.	N. J. and Mass.
Arsine	1 ppm.	N. J. and Mass.
Benzene (Benzol)	100 ppm.	N. J.
Butyl acetate	400 ppm.*	N. J. and Mass.
Butyl alcohol	200 ppm.*	N. J.
Carbon dioxide	5000 ppm.	N. J.
Carbon disulfide	20 ppm.	N. J. (15 ppm, Mass.)
Carbon monoxide	100 ppm.	N. J. and Mass.
Carbon tetrachloride	100 ppm.	N. J. and Mass.
Chlorine	1 ppm.	Mass.
Chlorodiphenyls	1 ppm.	Mass.
Chloronaphthalene	1 to 5 ppm.	Mass.
Dichloroethyl ether	15 ppm.	Mass.
Dichlorobenzene	75 ppm.	N. J. and Mass.
Dimethylaniline	5 ppm.	N. J.
Ether	400 ppm.	Mass.
Ethylene dichloride	100 ppm.	N. J. and Mass.
Formaldehyde	20 ppm.	Mass.
Gasoline (Petroleum)	1000 ppm.	N. J. and Mass.
Hydrochloric acid (Hydrogen chloride)	10 ppm.	N. J. and Mass.
Hydrogen cyanide	20 ppm.	N. J. and Mass.
Hydrogen fluoride	3 ppm.	N. J. and Mass.
Hydrogen sulfide	20 ppm.	N. J. and Mass.
Methyl alcohol	200 ppm.	N. J. and Mass.
Monochlorobenzene	75 ppm.	N. J. and Mass.
Mononitrotoluene	5 ppm.	N. J.
Nitrobenzene	5 ppm.	N. J. and Mass.
Nitrogen oxides	10 ppm.	Mass.
Ozone	1 ppm.	Mass.
Petroleum naphthas	1000 ppm.	N. J.
Phosgene	1 ppm.	N. J. and Mass.
Phosphine	1 ppm.	N. J.
Sulfur dioxide	10 ppm.	N. J. and Mass.
Tetrachloroethane	10 ppm.	N. J. and Mass.
Toluene (Toluol)	200 ppm.	N. J. and Mass.
Trichlorethylene	200 ppm.	N. J. and Mass.
Turpentine	200 ppm.	N. J. and Mass.
Xylene (Xylol)	200 ppm.	N. J. and Mass.
DUSTS AND FUMES		
Barium peroxide	0.5 mg. per cu.m.*	N. J.
Cadmium	0.1 mg. per cu.m.	N. J.
Chromic acid	0.1 mg. per cu.m.	N. J.
Lead	0.15 mg. per cu.m.	N. J.
Mercury	0.1 mg. per cu.m.	N. J.
Tetryl	1.5 mg. per cu.m.	N. J.
TNT	1.5 mg. per cu.m.	N. J.
Zinc oxides	15.0 mg. per cu.m.	N. J.
Silica (SiO_2)	5 m.p.p.c.f.	N. J.

* These are tentative values.

Abbreviations: ppm.—parts per million, by volume; mg. per cu.m.—milligrams per cubic meter of air; m.p.p.c.f.—millions of particles per cubic foot of air.

Toxicity of Various Industrial Chemicals. In the Table 7, the relative toxicities of the different chemicals treated in this chapter is indicated by dots. In each case it is the *vapor* (which is always present above any liquid) that is being considered. The dot does not indicate the effect of swallowing a liquid or eating a solid; although in general if the vapor is poisonous the liquid or solid state would be even more so, unless it is of the type that is quickly thrown off by vomiting. The meaning of the dots follows:

. . . *Extremely dangerous:* an hour exposure to even less than 1000 ppm. may produce severe injury.

. . *Dangerous:* an hour exposure to from 1000 to 10,000 ppm. may produce severe injury.

. *Not especially dangerous:* several hours exposure to from 10,000 to 100,000 ppm. may cause severe illness; or substance not volatile enough to cause danger.

No dot: insufficient data obtainable.

The reader may be surprised to learn that carbon monoxide, which causes so many deaths, is not violently poisonous (. .). It is so dangerous only because its common concentration about the household (in automobile exhaust or cooking gas) is usually so high—up to 15%.

TABLE 7. INDUSTRIAL POISONS AND SOLVENTS (Classified Chemically)

(For significance of dots see legend immediately above).

1. **Elements** (and special compounds associated with them)

Metals		*Nonmetals*
..antimony	...mercury	..selenium
...arsenic	...metallic fumes	...selenium oxychloride
...arsine	.nickel	...hydrogen selenide
...cadmium	..nickel compounds	..tellurium
..chromium	...nickel carbonyl	
...chromium compounds	...radium, etc.	
.copper	..thallium	
..copper compounds	...thallium compounds	
.iron	.tin	
...iron carbonyl	.vanadium	
...lead	..vanadium compounds	
.magnesium	.zinc	
.manganese	..zinc compounds	

2. Inorganic Compounds, containing

Carbon

.carbon dioxide
..carbon monoxide
...cyanogen
...hydrocyanic acid

Halogens

...chlorine
...bromine
..hydrochloric acid
...hydrofluoric acid
...phosgene

Nitrogen

...nitrogen oxides
...ammonia

Oxygen

.oxygen
...ozone

Phosphorus

...phosphorus
...phosphine
...phosphorous trichloride
...phosphorous oxychloride
...phosphorous pentachloride

Sulfur

..carbon disulfide
..carbon oxysulfide
...hydrogen sulfide
...sulfur dioxide
...sulfur trioxide
sulfur monochloride
sulfuryl chloride
thionyl chloride

3. Hydrocarbons

Chain (alifatic) hydrocarbons

.acetylene
.benzine
.butane
.ethane
.ethylene
.gasoline
.methane
..naphtha, and other petroleum mixtures
.propane
turpentine

Ring (aromatic) hydrocarbons

..benzene
.cyclohexane
.decalin
..ethyl benzene
naphthalene
..naphtha, solvent
.tetralin
..toluene
..xylene

4. Aliphatic (Chain) Derivatives

Acids

See Chapter 3.
acetic anhydride
formic acid
oxalic acid

Alcohols

See Chapter 3.

Aldehydes and Ketones

acetaldehyde
.acetone
formaldehyde
.methyl butyl ketone
.methyl ethyl ketone
.methyl isobutyl ketone
.methyl propyl ketone

Esters

..amyl acetate
.amyl acetate (sec.)
.amyl formate
.amyl phthalate
..butyl acetate
.butyl formate
butyl phthalate
diamyl phthalate
dibutyl phthalate
diethyl phthalate
dimethyl phthalate
...dimethyl sulfate
dipropyl phthalate
.ethyl acetate
ethylene glycol dinitrate
.ethyl formate
...ethyl silicate
.methyl acetate
methyl chloroformate
.methyl formate
nitroglycerin
.tri-o-cresyl phosphate

Ethers

..dioxane
.ethyl ether
.isopropyl ether
..ethylene oxide

Glycols

.diethylene glycol
.diethylene glycol monoethyl ether
.ethylene glycol
ethylene glycol dinitrate
ethylene glycol monoethyl ether
ethylene glycol monomethyl ether

Halogenated Chain Compounds

Saturated

.carbon tetrachloride
...chloropicrin
..chloroform
...dichloroethyl ether
...dichloromethyl ether
..ethyl chloride
..methyl chloride

Unsaturated

.acetylene dichloride
..acetylene tetrachloride
...allyl chloride
...chloroprene
.ethylene chloride
..ethylene dichloride
.methylene chloride
tetrachloroethylene
.trichloroethylene
.vinyl chloride

Brominated

..ethyl bromide
ethylene bromide
..methyl bromide
..ethylene dibromide

Mixed

.chlorine fluorine compounds

5. Aromatic (Ring) Derivatives

Chlorine

..chlorobenzene
.chlorinated diphenyls
.chlorinated naphthalenes
..dichlorobenzene

Nitrogen

...aniline
dinitrobenzene
..dinitrochlorobenzene
dinitrophenol
..nitrobenzene
..nitrochlorbenzene
phenylenediamine
picric acid
pyridine
...toluidine
trinitrotoluene

Others

cresols
cresylic acid
.cyclohexanol
.cyclohexanone
.hydroquinone
.methylcyclohexanol
phenol
.pyrocatechol
.pyrogallol
.resourcinol

6. Chemical Warfare Agents (All are not included in this book, but will be found in Jacobs, reference above).

...arsenic compounds
...chlorine
...cyanogen compounds
...dimethyl sulfate
...halogenated aromatics
...halogenated ethers
...halogenated formoxime
...halogenated ketones
...halogenated thioethers
.incendiaries
...nitro compounds
...phosgene
...smokes (war)

Data on Hazardous Chemicals

ACETALDEHYDE (CH_3CHO), acetic aldehyde, "aldehyde," or ethylaldehyde is a colorless liquid with a characteristic, pungent odor. It is used as an intermediate for many plastics and elastomers, also used for silvering mirrors, and in photography. Acetaldehyde is inflammable and in sufficient concentration can cause cyanosis. Paraldehyde is a liquid polymer formed from acetaldehyde.

ACETIC ANHYDRIDE [$CH_3(CO)_2O$] or acetyl oxide is a colorless liquid, resembling glacial acetic acid in odor, symptoms, and many properties. Acetic anhydride is used in making cellulose acetate rayons, dopes, plastics, etc., for general acetylations, and as a solvent for fats and volatile oils.

ACETONE (CH_3COCH_3), dimethyl ketone, β-ketopropane, propanone, or pyroacetic ether is a colorless, pleasant-smelling liquid. It is one of the most extensively used solvents for rubber, fats, oils, resins, waxes, cellulose acetate, lacquers, varnishes and rubber cements; as an intermediate for many synthetics; for absorbing acetylene gas, etc. Acetone burns, and the vapors of it explode easily. It is relatively harmless as a poison: for short exposures the vapor is about as toxic as benzene; long exposures may irritate the mucous membranes and cause headaches, fainting, and general poisoning.

ACETYLENE ($HC{\equiv}CH$) or ethine is an unsaturated hydrocarbon gas used in welding (oxyacetylene welding) and as an illuminant; it is increasing in importance as a raw material for many polymeric plastics and elastomers; also for acetaldehyde and other synthetics. It is chiefly a fire and explosion hazard; for although it is mildly anesthetic, 50,000 ppm. (53 mg./liter; 53 avoirdupois oz./1000 cu. ft.) can be tolerated for an hour. Dangerously poisonous arsine or phosphine may be present as impurities if the acetylene has been generated from calcium carbide and water.

ACETYLENE DICHLORIDE ($CHCl{=}CHCl$) or dichloroethylene, a colorless solvent with a slightly acrid odor, is used with fats, dry cleaners, insecticides, camphor and phenol; also used to re-

tard fermentation. In narcotic and anesthetic action it is somewhat less poisonous than carbon tetrachloride.

ACETYLENE TETRACHLORIDE ($Cl_2HC—CHCl_2$), tetrachloroethane, or tetrachloroacetylene (no longer called tetraline because of confusion with tetralin) is an important noninflammable solvent for fats, waxes, oils, resins, rubber, etc. Also used in the manufacture of paint and varnish removers, photographic films, dry cleaners, fire extinguishers, insecticides, etc. It is a colorless liquid having a suffocating odor; the inhaled vapors having a sweetish taste. It is one of the most poisonous chlorinated hydrocarbons, attacking the nervous system giving headaches, insomnia and dizziness; and the stomach, causing cramps, nausea and vomiting; and finally producing jaundice and death. A lethal concentration of 7300 ppm. (50 mg. / per liter; 50 avoirdupois oz. / 1000 cu. ft.) should be contrasted with the figure 25,000 for chloroform. The allowable working concentration in New Jersey and Massachusetts is 10 ppm.

ACIDS. See Chapter 3 for most industrial acids.

ACID, FORMIC (HCOOH), a colorless, pungent liquid, burns and is dangerously caustic to the skin. It is substituted for acetic acid in coagulating rubber latex, dehairing hides, tanning, and in chemical analysis. Applied externally it blisters the skin; and the blisters may spread. Vapors of it cause lachrymation and irritation of the nose and throat. It is the poison present in the sting of ants and some other insects.

ALCOHOLS. See Chapter 3.

ALKALIES. See **Barium, Calcium, Potassium,** and **Sodium Hydroxides** in Chapter 3.

ALLYL CHLORIDE ($CH_2Cl—CH{=}CH_2$), 3-chloropropylene, or chlorallylene, a colorless to yellowish, pungent, vile-smelling liquid, is extremely poisonous: some guinea pigs were killed by a 4-hour exposure to 300 ppm. (1 mg. / liter; 1 avoirdupois oz. / 1000 cu. ft.)

AMMONIA. See Chapter 3.

AMYL ACETATE, iso [$CH_3COO—CH_2—CH_2—CH(CH_3)_2$]

or amylacetic ester is the banana or pear oil long used in aluminum-base radiator paints; it is still used in modern bronzing liquids, in lacquers, for dyes, and for pear flavors. As little as 1 ppm. (0.005 mg. / liter; 0.005 avoirdupois oz. / 1000 cu. ft.) can be detected by its odor, and may cause coughing. One thousand ppm. for one hour irritates the mucous membranes, causing headache, dizziness, and nausea. Allowable working concentration in New Jersey is 400 ppm. Somewhat less irritating is **SECONDARY AMYL ACETATE** [$CH_3COOCH(CH_3)C_3H_7$] a yellowish, pungent solvent for lacquers, which is neither an explosive nor poison hazard, because of the warning of its disagreeable odor. Guinea pigs were affected, but not seriously, by an hour exposure to 10,000 ppm. (50 mg. / liter; 50 avoirdupois oz. / 1000 cu. ft.)

AMYL FORMATE ($HCOOC_5H_{11}$), **BUTYL FORMATE** ($HCOOC_4H_9$), and **ETHYL FORMATE** ($HCOOC_2H_5$) are colorless liquids used in lacquers, in the artificial leather and silk industries; also in making safety-glass plastic. None are very dangerous (amyl formate is more so than the others), since they warn by irritating the mucous membranes. They affect the central nervous system.

AMYL PHTHALATE, di-iso [$C_6H_4(COO—C_5H_{11})_2$], **DIBUTYL PHTHALATE** [$C_6H_4(COO—C_4H_9)_2$], **DIETHYL PHTHALATE** [$C_6H_4(COO—C_2H_5)_2$], **DIMETHYL PHTHALATE** [$C_6H_4(COO—CH_3)_2$], and **DIPROPYL PHTHALATE** [$C_6H_4(COO—C_3H_7)_2$] are all colorless, oily liquids used widely as plasticizers. Because they do not volatilize to any great extent, they do not appear to be especially harmful. Taken internally they produce nausea and vomiting.

ANILINE ($C_6H_5NH_2$) or aminobenzene is an oily solvent with a rather unpleasant odor; its color darkens in the air. Aniline is widely used as an intermediate in the dye, drug, and rubber industries. Acute poisoning, as from an exposure of 200 ppm. (0.8 mg. / liter; 0.8 avoirdupois oz. / 1000 cu. ft.) for an hour, may produce cyanosis, weakness, mental confusion, intoxication, convulsions, and death. Chronic poisoning may occur either from inhaling the vapor or by absorption through the skin; its symptoms are skin irritation,

eczema, anemia, and weak pulse; the blood and urine are brownish. Working concentrations range from 10 ppm. (Wisconsin) to 2.5 ppm. (California).

ANTIMONY (Sb). See Chapter 3.

ARSENIC (As). For arsenic salts see Chapter 3. Arsenic dusts are also a very serious source of poisoning, since so many minerals and ores contain arsenic compounds, sometimes only in traces.

ARSINE (AsH_3) is an especially dangerous compound, for it may form wherever hydrogen is produced in the presence of arsenic compounds. Arsine gives severe headache, difficulty in breathing, dizziness, cramps, fainting, nausea, and vomiting; the mucous membranes may be bluish and the urine dark. Later anemia and jaundice appear. Exposure of 60 minutes to 5 to 15 ppm. (0.02—0.05 mg. / liter; 0.02 to 0.05 avoirdupois oz. / 1000 cu. ft.) may produce serious illness; working conditions at concentrations many times smaller than 3 ppm. will produce symptoms, because the poison accumulates in the body. New Jersey and Massachusetts limit is 1 ppm.

BENZENE (C_6H_6), benzol, or cyclohexatriene is a clear, colorless, oily, and very inflammable liquid obtained from the distillation of coal tar, and widely used as a solvent and raw material in many organic chemical industries. Benzene is often mistaken for the petroleum product benzine, which is described below. Serious illness due to benzene is caused by an hour exposure of 5000 ppm. (16 mg. / liter; 16 oz. / 1000 cu. ft.). New Jersey limit is 100 ppm.

Symptoms. Chronic poisoning is indicated by headaches, dizziness, fatigue, ringing ears, heartburn, diarrhea, weak pulse, and a burning sensation in eyes, nose, and mouth. Chronic poisoning is likely to occur if the particular industry carries out evaporation of benzene with improper ventilation, as is likely during the winter months; young girls and pregnant women are especially susceptible.

Acute poisoning is more likely to occur from leaky valves or joints in those industries where benzene is kept in closed pipes. In addition to the symptoms accompanying chronic poisoning, there is fear of death, impaired vision, cyanosis, convulsions, and collapse; death may occur hours to days following exposure.

Treatment. Summon a physician immediately. A stimulant such as hot coffee or tea may be given. Keep the patient warm and quiet.

BENZINE (approximately C_8H_{18} to $C_{10}H_{22}$) is obtained during the fractional distillation of petroleum; it is the fraction that comes off between 110° and 150° C. Benzine causes headache, dizziness, and irritation of the skin and mucous membranes. Sixty minutes exposure to 7500 ppm. (about 40 mg. / liter; about 40 oz. / 1000 cu. ft.) may cause death; and working conditions should contain under 2000 ppm. Do not confuse benzine with benzene, discussed previously.

BROMINE (Br_2) is a heavy, dark, reddish brown, fuming, obnoxious (the word means stench) liquid used for brominating organic chemicals, for making silver bromide in photography, and for producing ethylene dibromide in enormous tonnages; this latter is added to leaded gasoline to react with and prevent free lead from pitting the cylinders of the motor car. Bromine resembles chlorine in its action on the lungs. Sixty minute exposure to 40 ppm. (0.022 mg. / liter; 0.022 oz. / 1000 cu. ft.) may cause death; 1 ppm. can be tolerated for several hours; and 3.5 ppm. can be detected by its odor.

BUTANE (C_4H_{10}) is a gaseous hydrocarbon used as a low-temperature solvent, in making synthetic rubber, and in "bottled gas" along with other hydrocarbon gases for household cooking. It resembles methane in hazard properties.

BUTYL ACETATE, normal ($CH_3COO—C_4H_9$) is a colorless liquid used in making safety-glass, plastics, artificial leather, lacquers, photographic film, etc. Concentrations well below the explosive and poisonous limits smell badly enough and irritate the mucous membranes sufficiently to give ample warning. Guinea pigs were slightly injured from exposure to 7000 ppm. (37 mg. / liter; 37 oz. / 1000 cu. ft.), but could tolerate 3300 ppm. for several hours. New Jersey and Massachusetts tentative working limit is 400 ppm.

BUTYL FORMATE is described under **Amyl Formate.**

CADMIUM (Cd) is used in welding, plating, low-melting alloys, dental amalgams, etc.; and in cadmium pigments and compounds. It

resembles arsenic or mercury in poisonous action. One milligram in 10 cubic meters of air is the permissible limit for factory air. Cadmium fumes and dust cause fatal pneumonia.

CARBOLIC ACID. See **Phenol** in Chapter 3.

CARBON DIOXIDE. See Chapter 3.

CARBON DISULFIDE (CS_2) or carbon bisulfide, used in many industries as a solvent, for manufacturing viscose rayon, in rubber, insecticides, soil disinfectants, etc., is a colorless or yellowish, vile-smelling, very inflammable liquid. As in most cases of industrial poisoning, chronic poisoning from the vapors is the chief danger. Exposure to about 1000 ppm. (3 mg./liter; 3 avoirdupois oz./1000 cu. ft.) may severely poison; workroom concentration should preferably be under 3 ppm. Massachusetts working limit is 15 ppm., New Jersey limit 20 ppm., but the California and Wisconsin limit is only 1 ppm.

Symptoms. Mild chronic poisoning causes giddiness and symptoms not unlike those caused by chloroform; acute poisoning acts on the nervous system causing temporary or permanent mental disturbances, affected vision, paralysis; also nausea and vomiting, pallor, and weak pulse.

Treatment. Summon a physician at once. Remove to fresh air; give a stimulant such as hot coffee or tea; keep the patient warm and quiet.

CARBON MONOXIDE (CO). See also Chapter 3. The great majority of asphyxia cases result from the inhalation of carbon monoxide gas. This deadly, odorless gas is known by several aliases, rightfully deserved, among them being, "perfect killer," "death gas," "invisible death," "creeping killer," and "Death's agent."

Carbon monoxide is very common, and can be found wherever there are appliances that burn coal, coke, gas, oil, or wood. It is found as a result of half-burning or incomplete combustion of carbonaceous materials, as in automobile and engine exhausts, in the celluloid industry, in mines after blasting, where metals are poured, where coal tar is distilled, where gas-heated irons are used; in the

home, where wood, coal, gas, or oil is not completely burned; in industries where there are leakages in blast furnaces; and in several other places too numerous to mention.

The hemoglobin of the blood has about three hundred times as great an affinity or attraction for carbon monoxide as it has for oxygen. Since the air we breathe contains about 21% of oxygen, the presence in the air of only one three-hundredth of that amount of carbon monoxide, or about 0.07% is sufficient, when breathed over an extended period, to saturate 50% of the blood hemoglobin and remove it from circulation in so far as its oxygen-carrying ability is concerned. The absorption of carbon monoxide by the blood increases with physical exertion, due to the increased rate and depth of respiration, hence the greater air intake. Persons having physical defects such as asthma, obesity, bronchitis, or chronic heart or vascular diseases are more susceptible to the effects of carbon monoxide. Sex has no apparent variation in susceptibility. Where there are two persons, one being larger than the other, or where there is an adult and a child, the smaller person absorbs the gas more rapidly and tends to develop the symptoms more quickly.

The blood of a person at rest may become nearly one-third saturated with carbon monoxide without causing appreciable symptoms; whereas if he uses any considerable muscular effort, the hemoglobin remaining free from carbon monoxide is not sufficient to transport the oxygen needed, and he may collapse. When his blood is more than half saturated, a person may collapse, even though at rest. If the victim remains in this condition for any time, the brain and other organs are injured by the continued lack of oxygen, and unconsciousness results.

Dangerous exposure for 60 minutes is 0.15% or 1500 ppm.; concentrations suitable for working several hours is 0.01% or 100 ppm. according to New Jersey and Massachusetts laws.

Symptoms. Carbon monoxide poisoning occurs in two stages. In the first stage there may be a tightness across the forehead; headache, throbbing at the temples, dizziness, weakness, weariness, nausea and vomiting, loss of muscular control, increased pulse and respiration, collapse, and finally unconsciousness. When the concentration

of carbon monoxide is high or when the victim is at rest, unconsciousness may result without any of these warning symptoms. In the second stage, the blood pressure falls, muscular control is lost, reflexes are dulled, intermittent convulsions may occur, the person breathes shallower, slower, and finally stops.

The effects of various concentrations of carbon monoxide are shown by the following.

Per cent of CO in air	*Poisonous effects in one hour*
0.01	none [legal working concentration in Massachusetts]
0.04	negligible
0.10	unpleasant, not dangerous
0.15	dangerous
0.40	fatal

Treatment. Carbon monoxide is eliminated through the lungs when fresh air is inhaled. Therefore the treatment is based on the elimination of the carbon monoxide from the blood. The process of elimination can be greatly increased by supplying oxygen to the lungs. This is accomplished by the inhalation of a mixture of 93% oxygen and 7% carbon dioxide. This process will remove carbon monoxide from the body many times faster than by normal breathing. If the victim ceases to breathe, artificial respiration should be started immediately (the Schafer Method is recommended, see p. 171). The circulation can be aided by keeping the victim warm with blankets, and properly wrapped heat applications. Before applying the heat applications (hot water bottles, chemical heat pads, etc.) they should be tested against the cheek or back of the hand to be reasonably sure they will not burn the patient. Complete rest is essential.

A gas as deadly as carbon monoxide should never be underestimated.

CARBON OXYSULFIDE (COS) is a colorless, practically odorless gas. Rabbits were seriously injured from 60 minutes exposure to 32 ppm.

CARBON TETRACHLORIDE (CCl_4) or tetrachloromethane (see Chapter 3) is a heavy, noninflammable liquid used mainly as a solvent for fats and oils; in textile soaps, rubber cements; as a dry cleaner; and in fire extinguishers. This last property of course makes it a useful solvent wherever there is any fire hazard. The principle danger is from inhaling vapors of carbon tetrachloride; although when it is used as a fire extinguisher there is also the hazard from its thermal decomposition to form deadly phosgene gas; for this reason carbon tetrachloride extinguishers should not be used in confined spaces. New Jersey and Massachusetts working limit is 100 ppm.

Symptoms. Nausea and vomiting, eye irritation, headache, pallor and weak pulse. More advanced stages experience abdominal pains and jaundice.

Treatment. Summon a physician without delay. Remove to fresh air; give hot coffee or tea as stimulant; keep the patient warm and quiet. Do not give alcohol.

CHLORINE (Cl_2). See also pages 62-3. Chlorine is a greenish-yellow gas at normal temperatures, and a liquid under pressure. Its use is so widespread that it is transported in tank cars.

The effects of leakage from only one commercial tank of chlorine can be shown by an incident that occurred in Brooklyn, New York on June 1, 1944. The results were felt principally in the subway station, into which the poisonous gas poured through a ventilator in the street. Passengers leaving the subway cars dropped in their tracks, some were knocked out, and others coughed and were deathly sick. Those receiving only slight poisoning were given first aid and taken home; others were hospitalized. In all, about one thousand were affected, and of this number about half received emergency treatment in some way or other. However no deaths were recorded.

One widespread use of chlorine is for water purification; and it is with this in mind that this section is included on the safety involved in its use and handling. When proper precautions are taken, chlorine can be handled with a reasonable amount of safety. Only because manufacturers and users have insisted upon certain safety fundamentals have accidents been kept at a low level.

To minimize danger if accidents do occur, the following suggestions are made: (1) Chlorine to be transported in trucks especially constructed for its transportation, and outfited with a hose for connecting to a hydrant. (2) Authorities to be notified before a truck passes through a municipality; and the truck to be properly marked as to its contents, with a sign on each side. (3) When used locally, names and telephone numbers of at least two physicians to be listed for use in the event of an accident, and posted where they are convenient for immediate use. (4) A gas mask, of the best type available, to be provided for those whose duty requires them to expose themselves to chlorine in event of an accident. This mask to be fitted properly to the individual for whom it is intended, and inspected often, and kept in proper working condition. A mask not properly fitted, or in need of repair, is worse than no mask at all. Extra masks to be available in the event that they are needed. Those persons whose duty it is to use these masks to be drilled in their use. (5) At the time of an accident to note the direction of the wind and to go upwind, so as to avoid a heavy concentration of the gas. To instruct persons leaving the gassed area to hold wet cloths to their mouths, which greatly decrease the chlorine inhaled. (6) A safety line to be attached to the man making repairs to chlorine apparatus; this line to run to a fellow worker outside the room or building, so that it can be easily followed if assistance is required.

It is fortunate that chlorine has an irritating odor and will give ample warning of its presence if there is a sudden leak, as from a tank.

Sixty minutes of 35 ppm. (0.1 mg. / liter; 0.1 avoirdupois oz. / 1000 cu. ft.) produces serious injury, but the odor is detectable even at 3.5 ppm. However, it is unsafe to work for many hours in an atmosphere that contains more than 0.1 ppm. The Massachusetts limit is 1 ppm.

Symptoms and Treatment. See Chapter 3, page 62.

CHLOROBENZENE (C_6H_5Cl), benzene chloride, phenyl chloride, or monochlorobenzene is an inflammable, colorless solvent for resins, acetate rayon, lacquers, etc.; it is also a dry cleaner. It is

about as toxic as benzene. Allowable working concentrations in New York and New Jersey are 75 ppm.

CHLORODIPHENYLS, a series of waxy solids containing from one to ten chlorine atoms in the molecule, are used for insulating electric wires, condensers, etc. against heat and moisture. A small percentage of persons die of yellow atrophy of the liver. Working conditions having more than 0.001 mg. / liter (0.001 avoirdupois oz. / 1000 cu. ft.) may produce dermatitis, and cause a fatty degeneration of the liver, which may continue on to yellow atrophy of the liver. Massachusetts has set a working limit of 1 ppm.

CHLOROFORM. See page 63.

CHLORONAPHTHALENES are similar to chlorodiphenyls in use and action, but only about half as toxic. A working concentration of 1 to 5 ppm. is allowed in Massachusetts.

CHLOROPICRIN (CCl_3NO_2), nitrochloroform, or trichloronitromethane, is a colorless liquid with a sharp sweetish odor resembling licorice; it causes tears to flow freely. Chloropicrin is used commercially to exterminate rats and vermin, to disinfect cereals and grain, and to sterilize soil; large quantities were used as a soil fumigant by Hawaiian pineapple growers. Used as a war gas, the British name "vomiting gas," and the nickname "puke stuff," for the American chemical warfare symbol (PS), indicate its physiological action.

Symptoms. Dangerous symptoms may be delayed for several hours after exposure. Other symptoms are nausea and vomiting, diarrhea, cramps, pallor. Chloropicrin is a dangerous lachrymator and lung injurant. A concentration of 60 ppm. (0.4 mg. / liter; 0.4 avoirdupois oz. / 1000 cu. ft.) will kill within an hour.

CHLOROPRENE ($CH_2{=}CCl{-}CH{=}CH_2$) or 2-chloro-1, 3 butadiene is a colorless liquid from which a certain type of synthetic rubber (such as neoprene, buna N) is made. Chloroprene lowers the blood pressure, induces detectable changes in the urine, and causes indigestion, and congestion in the throat. Illness may result from 200 ppm. (0.73 mg. / liter; 0.73 avoirdupois oz. / 1000 cu. ft.).

CHROMIUM (Cr) is found as chromic acid spray in chromium plating baths. "Chrome holes" (ulcers) are formed. Probable safe working concentration of chromic acid is 0.0001 mg. / liter (0.0001 avoirdupois oz. / 1000 cu. ft.).

COPPER (Cu). Poisoning from copper salts is common; see Chapter 3. Poisoning from fumes of the metal is rare since the boiling point is so high (2310° C.).

CRESOLS. See pages 67-8.

CYANOGEN (C_2N_2) is found in coal gas, and with hydrogen cyanide, resembling the latter in poisonous qualities. See page 34.

CYCLOHEXANE [$CH_2(CH_2)_4CH_2$], benzene hexahydride, hexahydrobenzene, or hexamethylene, is a colorless solvent for rubber, paints, and resins; also a degreasing agent. Reactions are similar to, but less severe, than benzene poisoning. Lethal concentrations are about 18,000 ppm. (60 mg. / liter; 60 avoirdupois oz. / 1000 cu. ft.).

CYCLOHEXANOL [$CH_2(CH_2)_4CHOH$], hexalin, hexahydrophenol, or hydrophenol, colorless liquid or hygroscopic needlelike crystals with an odor like camphor, is used for stabilizing emulsions in detergents, shoe cream, rubber, etc.; in insecticides, textile finishing; and as a rubber and nitrocellulose solvent. Although it paralyzes the nerves, its low volatility renders it less dangerous than benzene.

CYCLOHEXANONE [$CH_2(CH_2)_4CO$], ketohexamethylene, or pimelin ketone, a colorless liquid with a peppermint odor, is a solvent for cellulose plastics, dyes, fats, etc. It is not considered toxic.

DECALIN ($C_{10}H_{18}$), dekahydronaphthalene, dekalin, or naphthane is a commercial solvent for resins; in varnishes and lacquers; as a fuel; and in dry cleaning. Some investigators have claimed it is nontoxic, while others report dermatitis and systemic poisoning from it.

DIAMYL PHTHALATE and **DIBUTYL PHTHALATE** are described under **Amyl Phthalate.**

DICHLOROBENZENE, ortho ($C_6H_4Cl_2$), a colorless, inflammable solvent for waxes in lacquers and varnishes, is also used in manufacturing dyes, in fumigating, in destroying termites, in desulfurizing illuminating gas, and in preserving plants. It is about as toxic as carbon tetrachloride. New Jersey and Massachusettts have set 75 ppm. as the allowable working concentration.

DICHLOROBENZENE, para ($C_6H_4Cl_2$) is a white crystalline solid, widely sold as a moth repellent. It is also used in dog-itch ointment; to kill lice, vermin, peach-tree borers, roaches, etc. It resembles ortho-dichlorobenzene in physiological action; but the para compound, being a solid, does not vaporize sufficiently to be dangerously poisonous.

DICHLORO-DIFLUORO-METHANE (CCl_2F_2) is a colorless, noninflammable, nonexplosive, nontoxic gas. Trade names: Freon, F-12, Kinetic No. 12. **DICHLORO-TETRAFLUORO-ETHANE** (CCl_2F_4) is a nontoxic liquid; trade name F-11. The poisonous member of this group is **TRICHLORO-FLUORO-METHANE** (CCl_3F), a colorless gas; trade name F-114: two hours' exposure to 100,000 ppm. (10%) caused guinea pigs to lose coordination.

DICHLORO DIPHENYL TRICHLOROETHANE [$(ClC_6H_4)_2C_2HCl_3$], popularly named D.D.T., is today widely used against fleas, lice, mites, ticks, etc. It has also been used in antifouling paint against barnacles on the hulls of ships. Roaches are killed by it only upon long and frequent exposure. Solutions containing up to 10% D.D.T. in organic solvents are sprayed to rid homes of flies and mosquitoes, and in attempts to prevent carrying such viruses as those causing infantile paralysis.

The solution is toxic if taken internally, or if absorbed from contact with the skin for many minutes. Care should be exercised to avoid inhalation, ingestion, or continued contact with the skin. Never spray near exposed food. D.D.T. coated on inert powder is also available for household pets; it cannot be dusted on cats because in using their tongues to clean themselves they would ingest the poison.

Symptoms. Nausea and vomiting; rapid, weak pulse; pallor.

Treatment. Summon a physician immediately. Give an emetic of mustard and water, repeating several times. Follow with whites of eggs, and milk. Keep the patient quiet and warm. *External treatment:* wash thoroughly with large quantities of soapy water.

DICHLOROETHYL ETHER, symmetrical [$(ClC_2H_4)_2O$] or β,β'-dichloroethyl ether is a colorless solvent used to remove naphthenic components from lubricating oils; also as a solvent for fats, resins, etc.; as a high-temperature dry cleaner; for scouring textiles; and as a soil fumigant and insecticide. Because it stimulates excessive lachrymation, acute poisoning is unlikely; however, if it is breathed in very low concentrations for long periods, serious irritation of the respiratory system results. An hour's exposure to 500 ppm. (2.2 mg. / liter; 2.2 avoirdupois oz. / 1000 cu. ft.) seriously injures; 35 ppm. gives slight symptoms after 8 hours. The Massachusetts working limit is 15 ppm.

DICHLOROMETHYL ETHER, symmetrical [$(ClCH_2)_2O$] is a colorless, suffocating liquid used as a solvent. It is also a war gas, producing dizziness and staggering; 3 ppm. (0.014 mg. / liter; 0.014 avoirdupois oz. / 1000 cu. ft.) irritates distinctly; 100 ppm. will kill in a few minutes.

DIETHYLENE GLYCOL [$(HOC_2H_4)_2O$] or β,β'-dihydroxy-diethylether is a colorless solvent for vat dyes, a plasticizer, and intermediate for manufacturing resins and esters; also used as an antifreeze solution in refrigerator systems, and as a finishing agent for textiles. Because it is sweet and hygroscopic it is also used for moistening tobacco. Over seventy persons were killed in 1937 from taking "Elixir Sulfanilamide" in which diethylene glycol was the solvent. It caused stoppage of urine, intense cramps, nausea and vomiting, stupor, and death. Seven cc. taken orally will kill a rat weighing a pound.

DIETHYLENE GLYCOL MONOETHYL ETHER ($HO—C_2H_4—O—C_2H_4—OC_2H_5$) is a slightly hygroscopic, colorless solvent for plastics, dyes, and oil; also for plasticizers as in safety-glass plastic. It is less toxic than ethylene glycol.

DIMETHYL SULFATE [$(CH_3)_2SO_4$] or methyl sulfate, a colorless, oily liquid with an onion odor, is an important methylating agent. Even the vapor is a dangerous lachrymator and vesicant, and a poison war gas; it is as toxic as phosgene. An hour's exposure to 20 ppm. (0.1 mg. / liter; 0.1 avoirdupois oz. / 1000 cu. ft.) kills. Flushing the skin with hot water or alkalies destroys it.

DINITROCHLOROBENZENE [$ClC_6H_3(NO_2)_2$], 2-, 4-dinitrochlorobenzene, or 4-chloro-1-, 3-dinitrobenzene, yellow crystals used in the dye industry, and for detecting nicotinic acid and other pyridine derivatives, is a powerful skin irritant. The dust is definitely more poisonous than nitrochlorobenzene.

DINITROPHENOL, alpha [$HOC_6H_3(NO_2)_2$] or 2-, 4-dinitrophenol forms yellow rhombohedrons that are an explosive and dyestuff intermediate; also a pH indicator. Used in medicines for obesity; it has caused death, producing fever, sweating, rapid, weak pulse, and skin irritation.

DIOXANE ($\overline{C_2H_4—O—C_2H_4—O}$), 1, 4-dioxane, or diethylene-dioxide is a ring ether; it is a colorless, mildly pleasant solvent used in the lacquer and plastic industry; and as a preservative, fumigant, deodorant, and wetting agent. Authorities disagree as to the exact toxic concentrations, but 5000 ppm. (18 mg. / liter; 18 avoirdupois oz. / 1000 cu. ft.) for an hour produces lachrymation, and a burning sensation in the nose and throat. Dioxane may also be absorbed through the skin.

ETHANE (C_2H_6) is a colorless, gaseous hydrocarbon used in fuels and as a refrigerant. See **Methane.**

ETHER. See Chapter 3.

ETHYL ACETATE ($CH_3COO—C_2H_5$), acetic ether, or vinegar naphtha, a colorless liquid possessing an odor of apples, is used in manufacturing other fruit flavorings and perfumes, and as a solvent and intermediate in preparing plastics, explosives, lacquers, etc. Ethyl acetate is not especially poisonous, although high concentrations or continued exposure may irritate the nose, throat, or skin, or even have a narcotic effect.

ETHYL BENZENE ($C_6H_5—C_2H_5$) or phenylethane, a colorless, pungent, inflammable, irritating liquid, is used as an antiknock in airplane fuels, and for preparing certain sterols. Because of its irritating effect a human being could not remain in a dangerously high concentration; guinea pigs were killed by an hour's exposure to 10,000 ppm. (40 mg. / liter; 40 avoirdupois oz. / 1000 cu. ft.), which caused them first to become dizzy, unconscious, gasping, and trembling.

ETHYL BROMIDE (C_2H_5Br), bromoethane, monobromoethane, bromic ether, or hydrobromic ether, a colorless solvent, refrigerant, anesthetic, and ethylating agent, forms explosive and inflammable mixtures with air. Action is similar to methyl chloride. An hour's exposure to 10,000 ppm. (45 mg. / liter; 45 avoirdupois oz. / 1000 cu. ft.) caused severe damage to animals; about 2000 ppm. for several hours did not injure.

ETHYL CHLORIDE (C_2H_5Cl) or chloroethane, a very inflammable gas used in refrigeration; and as a local anaesthetic. Although it resembles methyl chloride in physiological effects, ethyl chloride does not irritate the lungs so much; for this reason a person may unwittingly become dangerously exposed to ethyl chloride.

ETHYLENE (C_2H_4) an unsaturated hydrocarbon present in illuminating and petroleum gases artificially ripens fruits and bleaches vegetables. Although anesthetic in sufficiently large quantities, its chief hazard is from fire and explosion.

ETHYLENE DIBROMIDE [$(CH_2Br)_2$], a colorless, heavy liquid used in some fire extinguishers, exceeds chloroform in narcotic action, which it resembles in odor. It is an important ingredient of ethyl fluid and ethyl gasoline.

ETHYLENE DICHLORIDE [$(CH_2Cl)_2$], 1-, 1-Dichloroethane, or Dutch liquid is a very stable solvent. It is finding increased use for dipped rubber goods, edible oils, and fats. Its chloroform-like odor and irritation of the nose and eyes is a protection against poisoning. Exposure to 4000 ppm. (12 mg. / liter; 12 avoirdupois oz. / 1000 cu. ft.) for an hour produces serious illness; New Jersey

and Massachusetts have set a limit of 100 ppm. as an allowable working concentration.

Symptoms. Nausea and vomiting; headache; irritation of the eyes, nose and throat; pallor; weak pulse, subnormal temperature; dizziness; partial paralysis; and unconsciousness.

Treatment. Summon a physician immediately. Remove to fresh air; give a stimulant such as hot coffee or tea; keep the patient warm and quiet.

ETHYLENE GLYCOL [$(CH_2OH)_2$] or glycol is a syrupy solvent, used as an antifreeze and explosive intermediate, textile dye and finish, gas meter lubricant, and in phthalate resins. Its hydroscopic nature adapts it as a moistener for tobacco. Ethylene Glycol slightly affects the blood, muscles, and nerves, and irritates locally Trade name: Prestone.

ETHYLENE GLYCOL DINITRATE [$(CH_2—ONO_2)_2$] is a yellow liquid that is an explosives intermediate. It explodes at about 115° C. Its toxic effects resemble nitroglycerin, but the former may appear more toxic because it is more volatile.

ETHYLENE GLYCOL MONOETHYL ETHER ($HOCH_2—CH_2OC_2H_5$) is a colorless plastics solvent and lacquer thinner. Its low volatility makes it unlikely to poison seriously; and its pleasant odor makes it suitable for household lacquers, where prolonged exposure is unlikely. However, continued exposure to low concentrations may cause chronic poisoning.

ETHYLENE GLYCOL MONOMETHYL ETHER ($HOCH_2—CH_2OCH_3$) is a faintly-smelling solvent for cellulose acetate and nitrate plastics, lacquers, and dopes; in dye baths; and as a stabilizer for emulsions. Also it is used in "Jaysonizing" to prepare stiff shirt cuffs and collars. Working conditions in which there is more than 25 ppm. (0.07 mg. / liter; 0.07 avoirdupois oz. / 1000 cu. ft.) may poison the blood.

ETHYLENE OXIDE ($\overline{CH_2—CH_2—O}$), a ring compound and colorless gas, is a liquid below 12° C. It is used as a fumigant for

foodstuffs and textiles. Allowable concentrations warn by irritating the eyes and nose; great exposures produce nose bleeds, intoxication, gasping, and death. Guinea pigs were seriously injured by 3000 ppm. (54 mg. / liter; 54 avoirdupois oz. / 1000 cu. ft.) but tolerated 250 ppm. for several hours.

ETHYL ETHER. See Chapter 3.

ETHYL FORMATE is described under **Amyl Formate.**

ETHYL SILICATE, ortho [$(C_2H_5)_4SiO_4$] or tetraethyl orthosilicate, a colorless, pungent, inflammable liquid, is a binding material and hardening agent, in waterproof cements and ceramics. Concentration of 85 ppm. can be smelled; and 700 ppm. (6 mg. / liter; 6 avoirdupois oz. / 1000 cu ft.) irritates the eyes and nose; this concentration is dangerous for a 30-minute exposure.

FORMALDEHYDE. See Chapter 3.

GASOLINE. See Chapter 3.

HYDROGEN SULFIDE. See Chapter 3.

HYDROQUINONE [$C_6H_4(OH)_2$], parahydroxybenzene, hydroquinol, or quinol forms colorless crystals used in an old-type photographic developer. The dust irritates the skin of workers, and discolors the eyes. See **Resourcinol, Pyrocatechol.**

IRON (Fe) is not harmful. But iron carbonyl is poisonous, like nickel carbonyl.

ISOPROPYL ETHER [$((CH_3)_2CH)_2O$] or diisopropyl ether, a colorless solvent with an ethereal, camphorlike odor is used to improve motor fuel performance. An hour's exposure to 30,000 ppm. (125 mg. / liter; 125 avoirdupois oz. / 1000 cu. ft.) produces intense intoxication or death; less than 10,000 ppm. is assumed a safe working concentration for short periods.

LEAD (Pb) salts (Chapter 3) and lead dust are extremely poisonous. M. B. Jacobs indicates that lead compounds may be many times more soluble in the blood than in water: thus lead monoxide is 68 times more soluble; lead carbonate 20 times more soluble; and

lead which is practically insoluble in water dissolves to the extent of 578.0 mg. per liter of serum. Lead sulfate is about equally insoluble (44 mg. / liter) in both solvents.

Inhalation of about 2 mg. of lead dust a day will develop lead poisoning in a few years. In other words, minute quantities taken at frequent intervals fail to excrete rapidly enough from the system, and in time accumulate to a point where the body tolerance is exceeded. Approximately 0.015 ppm. (0.000, 15 mg. / liter; 0.000, 15 avoirdupois oz. / 1000 cu. ft.) is generally accepted as the maximum safe concentration in a workroom. According to Jacobs this may be compared with a usual concentration of 0.000,01 mg. per liter normally in the atmosphere of industrial establishments, 0.000,013 mg. in auto repair shops, and 0.000,009 mg. at congested street intersections.

Symptoms. Nausea and vomiting, cramps, diarrhea followed by obstinate constipation, metallic taste in the mouth, weakness, pallor, blue lead line on the gums at their junction with the teeth, weak pulse, headaches.

Treatment. Summon a physician at once. Give a stimulant such as hot coffee or tea. Keep the body warm and quiet.

MAGNESIUM (Mg) is a silvery white substance, about two-thirds the weight of aluminum. At high temperatures it reacts violently with water, liberating hydrogen; and with carbon dioxide, liberating carbon. Water will not therefore extinguish such a fire; and carbon dioxide extinguishers are useful only if they can chill the burning magnesium below its ignition temperature. Magnesium fires are either slow burning or of the flash type, depending upon the fineness of division of the burning particles (e.g. flashlight powder). The heat from a flash fire is tremendous, and severely burns and injures the skin. The dust itself is not a poison hazard.

Symptoms. Burning magnesium gives second and third degree burns.

Treatment. Summon a physician. Relief from shock and pain are probably the most important emergency steps. Most doctors pre-

fer to have the burn left alone, so that they can apply the particular burn application which their experience has proved most satisfactory. If a burn application is to be used, it is suggested that one of the water soluble type be employed.

MANGANESE (Mn) is a hard, brittle, lustrous metal. The salts are usually pink. Manganese is of greatest importance for making extremely hard steels as for safes, heavy-duty rails and machinery, rock-crusher jaws, etc. Manganese compounds are used in glass, as manganese resinates in paint driers, as black manganese dioxide in electric dry cells, etc. Poisoning results from inhalation of fumes and dusts, but is found only in special industries.

Symptoms. Nausea and vomiting, diarrhea, headache, stiffness of the muscles, twitching, pallor, weak pulse, defective speech, affected gait and drowsiness.

Treatment. Summon a physician at once. Give a stimulant of hot coffee or tea; keep the patient warm and quiet.

MERCURY (Hg). See Chapter 3 for **Mercury** salts. Mercury dust poisoning is likely to occur wherever large quantities of mercury is handled, for mercury has a theoretical vapor pressure of 1.84 ppm. (0.0152 mg. / liter; 0.0152 avoirdupois oz. / 1000 cu. ft.) at 20° C. This was the source of poisoning, for instance, to workers using mercuric nitrate for carrotting furs and felt hats. The question of dangerous concentrations is much debated; Massachusetts sets a working limit of 0.001 ppm. (0.0001 mg. / liter; 0.0001 avoirdupois oz. / 1000 cu. ft.) although some workers may withstand several times this amount without becoming ill. Other symptoms include a metallic taste in the mouth; redness of gums, cramps, headache, diarrhea or constipation, extended fingers.

METALLIC FUMES from almost any readily volatilized metal may give a metal fume fever known as brass chills, oxide chills, zinc oxide fever (although it is by no means limited to zinc oxide), brass founder's ague, or metal shakes. Toxicity is apparently related to the small size of the particles rather than to the chemical nature of the metal.

Symptoms. Constriction in the chest region, a dry cough, nausea and vomiting, diarrhea, headache, pallor, weak pulse, affected vision, subnormal temperature, and chills.

Treatment. Summon a physician at once. Give a stimulant of hot coffee or tea; keep the patient warm and quiet.

METHANE (CH_4), fire damp, marsh gas, or miner's gas is an odorless gas found in all coal mines, in some other mines, and in sewer gas. Manufactured coal gas, coke-oven gas, or oil gas contains about 30% methane, 50% hydrogen, and 5 to 15% carbon monoxide; it is the presence of this latter component that is the chief danger from cooking gas. Butane, ethane, and propane act like methane; none of them are really poisonous; that is, a 5% concentration (50,000 ppm.) would not injure, though it might be mildly anesthetic; but these hydrocarbon gases are very dangerous explosion and fire hazards, or poisonous because of the carbon monoxide present as an impurity in the gases. See **Sewer Gas.**

METHYL ACETATE ($CH_3COO—CH_3$), a colorless, pleasant-smelling solvent for plastics, resins and fats, and also used in manufacturing artificial leather, is not especially poisonous, although 10,000 ppm. (30 mg. / liter; 30 avoirdupois oz. / 1000 cu. ft.) irritates the eyes, nose and throat, and causes headache; it reacts with water to form methyl alcohol, so that the liquid is dangerous if swallowed.

METHYL BROMIDE (CH_3Br), bromomethane, or monobromomethane is a colorless gas used as a refrigerant, insecticide, fumigant, and as a delousing agent for clothes. It is dangerous because it gives little warning; for its action is delayed and its odor not too unpleasant. It volatilizes very rapidly. An hour at 2000 ppm. (8 mg. / liter; 8 avoirdupois oz. / 1000 cu. ft.) seriously injures; 50 ppm. may be safe working conditions. Because of its toxicity, improvements in ventilation and operations to increase safety have been introduced.

Symptoms. Nausea and vomiting; headache; pallor; weak pulse; affected vision; drowsiness; faintness, and collapse. Pneumonia

often develops. Severe burns are caused when methyl bromide comes in contact with the skin.

Treatment. Send for a physician at once. Give a stimulant of hot coffee or tea. Keep the patient warm and quiet.

METHYL BUTYL KETONE, normal ($CH_3CO—C_4H_9$) or hexanone-2, a colorless liquid with an odor somewhat milder than acetone, is used as a solvent for nitrocellulose and Vinylite. Guinea pigs were killed from an hour exposure at 10,000 ppm. (40 mg. / liter; 40 avoirdupois oz. / 1000 cu. ft.) but tolerated 1000 ppm. for 13½ hours with no obvious effects. This latter concentration is not inflammable, and warns man by its distinct odor and irritation of the eyes and nose. **METHYL ISOBUTYL KETONE** [$CH_3CO—CH_2CH(CH_3)_2$], 4-dimethyl pentanone or hexone is a colorless solvent used in lacquers and varnishes. Guinea pigs were killed by 4 hours exposure to 10,000 ppm. (40 mg. / liter; 40 avoirdupois oz. / 1000 cu. ft.) but tolerated 1000 ppm., a concentration that warns man by irritating the eyes and nose.

METHYL CHLORIDE (CH_3Cl), chloromethane, or monochloromethane is a colorless liquid with an ethereal odor and sweetish taste. Although inflammable, it is less so than gasoline. Methyl chloride is a refrigerant. It is a dangerous poison. An exposure of one hour to 20,000 ppm. (40 mg. / liter; 40 avoirdupois oz. / 1000 cu. ft.) is dangerous to life; 500 ppm. is a safe working condition for a few hours according to California law.

Symptoms. Nausea and vomiting; drowsiness; mental confusion; fever; convulsive, rapid respiration; rapid, weak pulse; coma, and death.

Treatment. Send for a physician immediately. Give a stimulant of hot coffee or tea; keep the patient quiet and warm.

METHYL CHLOROFORMATE ($ClCOOCH_3$) or methyl chlorocarbonate, a colorless, liquid lachrymator, is admixed with hydrocyanic acid fumigants as a warning agent.

METHYL CYCLOHEXANOL [$CH_3(C_6H_{10})OH$], hexa-

hydrocresol, or hexahydromethyl phenol is a mild nose and throat irritant, similar to cyclohexanol in properties and uses.

METHYLENE CHLORIDE (CH_2Cl_2), dichloromethane, or methylene bichloride, a colorless, noninflammable solvent for fats, rubber, and cellulose acetate, is also used in cleaning fluids and paint removers, and occasionally as a local anesthetic. It is somewhat less toxic than methyl chloride. Do not confuse with methylene bichloride Eastman, which is a mixture of methyl and ethyl chlorides.

METHYL ETHYL KETONE ($CH_3CO—C_2H_5$) or butanone, a colorless solvent with a more pleasing odor than acetone, is used in lacquers and paint removers; and in the manufacture of colorless resins and smokeless powders. Concentrations sufficiently high to irritate the eyes and nose are neither inflammable nor particularly toxic. Guinea pigs suffered from one hour's exposure to 50,000 ppm. (160 mg. / liter; 160 avoirdupois oz. / 1000 cu. ft.) but tolerated 3000 ppm. for several hours.

METHYL FORMATE ($HCOOCH_3$), a colorless, inflammable, liquid with a pleasant odor, is used as a foodstuffs and tobacco larvicide, and as a refrigerating liquid. Its odor and mild irritating action warn before any serious poisoning may occur, but the danger of explosion exists unless it is mixed with carbon dioxide. Guinea pigs were injured in 60 minutes by 15,000 ppm. (33 mg. / liter; 33 avoirdupois oz. / 1000 cu. ft.) but tolerated 2000 ppm. for several hours.

METHYL PROPYL KETONE, normal ($CH_3CO—C_3H_7$), ethyl acetone, or pentanone-2 resembles methyl butyl ketone in properties and use, but is slightly less toxic.

NAPHTHA (approximately C_4H_{10} to C_8H_{18}) is obtained by the distillation of petroleum. See **Petroleum** for the boiling points of various fractions. It is highly inflammable; but is used as a solvent, for degreasing, and in certain paints and insecticides, and in photography. It should be distinguished from Solvent naphtha, a coal-tar product described in the next paragraph. Petroleum naphtha causes headache, dizziness, irritation of the membranes, and dermatitis. One hour exposure to 7000 ppm. (25 mg. / liter; 25 avoirdupois oz.

/ 1000 cu. ft.) is dangerous; safe working concentrations in New Jersey are under 1000 ppm.

NAPHTHA (SOLVENT) is a liquid mixture of organic ring compounds of coal-tar origin, in contrast to the naphtha described in the preceding paragraph. Solvent naphtha is a dilutent and solvent for lacquers, oils, gums, etc. It contains benzene, xylol, toluene, ethyl benzene, etc., and combines their poisonous properties.

NAPHTHALENE ($C_{10}H_8$). See Chapter 3.

NICKEL (Ni) is used in plating. Nickel dust is not especially dangerous. Nickel salts are somewhat less dangerous than the corresponding copper salts. But **NICKEL CARBONYL** [$Ni(CO)_4$] or nickel tetracarbonyl is a yellow liquid that explodes at around 60° C. It is used in the Mond process for purifying nickel. It is very poisonous indeed: 60 minutes' exposure to 180 ppm. (2 mg. / liter; 2 avoirdupois oz. / 1000 cu. ft.) killed rabbits.

NITROBENZENE ($C_6H_5NO_2$), nitrobenzol, essence or oil of mirbane, a yellowish, oily liquid with an odor of oil of bitter almonds (like benzaldehyde), is used to manufacture aniline; also in explosives, dyes, and shoe polishes. Absorption through the skin from spilled liquid is common; the vapor is even more toxic. Nitrobenzene produces pronounced cyanosis, nausea and vomiting, intoxication, respiratory failure and coma; it also poisons the nerves, causing tremors, etc. An hour's exposure to 200 ppm. (1.0 mg. / liter; 1 avoirdupois oz. / 1000 cu. ft.) may be tolerated without serious injury; working concentrations should definitely be under 40 ppm. and are fixed in Massachusetts and New Jersey at 5 ppm. **META-DINITROBENZENE** [$C_6H_4(NO_2)_2$], similar to nitrobenzene in toxicity, forms colorless, or yellowish, rhombohedrons used as an explosives intermediate.

NITROCHLOROBENZENE, ortho-para mixture (Cl $C_6H_4NO_2$) when impure is a liquid; it is used in the manufacture of explosives. Its poisonous effect can be cumulative; it is a blood poison slightly more dangerous than nitrobenzene. Trade name: Tropfoel.

NITROGEN OXIDES (NO; NO_2; N_2O_3; N_2O_4; and N_2O_5), so-called nitrous fumes, are a great hazard in a number of chemical industries: the lead chamber process, the manufacture of explosives, photographic film, celluloid, other pyroxylin products, and fertilizers. Nitrogen oxides are dangerous because a lethal dose gives no warning: following unrealized exposure the worker may succumb the next day. Probably one of the most dangerous conditions arising from its inhalation is pulmonary edema (developing several hours after exposure), similar to that suffered from chlorine or phosgene poisoning. Many of the deaths from the fire that occurred in the Coconut Grove Club in Boston in 1942 were due to nitrogen oxides that formed. Sixty minutes at a nitric oxide concentration of 100 ppm. (0.12 mg. / liter) can cause illness; 10 ppm. can be safely tolerated for several hours; this is the working concentration limit in Massachusetts.

Symptoms. Choking, coughing, nausea and vomiting, bloody expectoration, weak pulse, pallor, cyanosis, and collapse.

Treatment. Summon a physician immediately. Keep the patient warm and quiet (complete rest is very important). It may be necessary while awaiting the physician's arrival to administer oxygen to relieve the cyanosis.

NITROGLYCERIN [$C_3H_5O_3(NO_3)_3$] or glyceryl trinitrate is a yellow liquid that explodes on being jarred, or at 260° C. When tasted or applied to the skin, it is likely to produce a violent headache. Poisoning is evidenced by a thumping heart, flushed face, intense headache; and at times nausea and vomiting, and unconsciousness.

Spirit of glyceryl trinitrate, or Spirit of Glonoin, or Solution of glyceryl trinitrate, is an approximately 1% solution of nitroglycerin in alcohol, used medicinally as a vasodilator. If tasted or applied to the skin, the solution produces a violent headache. **Danger:** if spirit of glyceryl trinitrate is spilled, immediately add a solution of sodium hydroxide to chemically destroy it; otherwise the alcohol will evaporate, leaving an explosive residue.

NITROUS OXIDE (N_2O) or laughing gas. See **Ether,** page 72.

OXYGEN (O_2) is not a poisonous gas; but it is an explosion hazard, particularly with traces of oil, such as might accidentally be applied to the reducing valves in inhalators and resuscitators.

OZONE (O_3) is a colorless gas with a characteristic, bracing odor. It is used industrially as a bleach, for purifying air and water, and for manufacturing potassium permanganate. Safe working concentrations have been estimated variously at 1 ppm. (State of Massachusetts) to 0.15 ppm. (Dalla Valle).

PETROLEUM is a mixture of several hundred compounds of carbon and hydrogen (hydrocarbons). Distillation yields the following fractions:

Name	*Approximate Number of C Atoms*	*Boiling Point Range °C.*	*Uses*
Gases	CH_4 to C_4H_{10}	−162 to +0.3	fuel, carbon black
Petroleum ether	C_4 to C_7	20 to 60	solvent
Petroleum benzine	C_4 to C_8	40 to 90	solvent
Petroleum naphtha	C_4 to C_9	65 to 120	solvent
Gasoline	C_4 to C_{13}	40 to 225	motor fuel
Benzine	C_4 to C_{10}	110 to 150	fuel; cleaner
Kerosene	C_{10} to C_{16}	175 to 300	fuel; lighting
Middle fraction gas oils	about 40% crude oil	225 to 375	cracked into gasoline
Lubricating oils	.....	350	lubrication
Paraffin	.....	solid	candles; water proofing
Tar residue	.....	"	paving, roofing
Coke	.....	"	fuel

PHENOL (C_6H_5OH). See Chapter 3.

PHENYLENEDIAMINE, para [$C_6H_4(NH_2)_2$], paradiaminobenzene, or Ursol D forms red to white crystals, which darken in the air. It is a photographic developer and fur dye. Numerous cases record its irritating effect on workers in rubber factories, or on persons wearing furs dyed with phenylenediamines. It also severely injures the eyes.

PHOSGENE ($COCl_2$) is a colorless war gas formed by thermal decomposition of chlorinated hydrocarbons in dyeworks and other chemical plants. Dangerous quantities may be formed if carbon tetrachloride is used to extinguish fires in small rooms. Note that

phosgene contains no phosphorus. The victim may not evidence serious poisoning for several hours after being poisoned.

Symptoms. Tightness in the chest region, coughing, headache, often bloody sputum, and bad taste if attempt is made to smoke a cigarette. The tiny sacs in the lungs fill with body fluid, probably mix with hydrochloric acid formed from the hydrolysis of phosgene in the lungs. A 60-minute exposure of 10 ppm. (0.044 mg. / liter; 0.044 avoirdupois oz. / cu. ft.) is dangerous; maximum working concentration is 1 ppm. (Massachusstts and New Jersey). A concentration of 5.6 ppm. can be smelled, and so gives warning.

Treatment. Summon a physician at once. While waiting for the physician to arrive, keep the patient warm and quiet, absolutely quiet, as the slightest exertion may result in the victim's collapse. Do not administer artificial respiration, but oxygen may be given in its place.

PHOSPHINE (PH_3), not to be confused with **Phosgene** above, is a colorless, nauseating gas found as an impurity in the manufacture of the following materials: acetylene from calcium carbide, P_4S_3 for safety matches, phosphorus, and ferrosilicon. Phosphine causes headache, loss of appetite, thirst, and dizziness. Exposure for 60 minutes at 400 ppm. (0.56 mg. / liter; 0.56 avoirdupois oz. / 1000 cu. ft.) may kill; safe working conditions is 2 ppm. or under; in New Jersey the limit is 1 ppm. Certain yellow to brown dyes are also called phosphines.

PHOSPHORUS (P). See Chapter 3.

PHOSPHORUS TRICHLORIDE (PCl_3) or phosphorous chloride, is a colorless, pungent liquid, which fumes in the air. It is used for chlorinating organic compounds, and in the manufacture of two other chlorinated products: **PHOSPHORUS PENTACHLORIDE** (PCl_5), phosphoric chloride, or phosphorous perchloride, deliquescent crystals, and **PHOSPHORUS OXYCHLORIDE** ($POCl_3$), or phosphoryl chloride, a colorless, fuming, pungent liquid. All three compounds suffocate, inflame the lungs and passages, and cause lachrymation; the expectoration is bloody. Fifty ppm. (0.3 mg. / liter; 0.3 avoirdupois oz. / 1000 cu. ft.) of PCl_3

for an hour injures seriously; exposure to a concentration of 0.7 ppm. for several hours was found not dangerous.

PICRIC ACID [$HOC_6H_2(NO_3)_3$]. See page 87.

PROPANE (C_3H_7) is a gaseous hydrocarbon found in "bottled gas," and also used as a raw material for a number of organic chemicals, and in case hardening. See **Methane.**

PYRIDINE (C_5H_5N) is a colorless to brownish solvent for anhydrous mineral salts, and is also used to manufacture organic compounds. Its repulsive odor suits for use as a denaturant for ethyl alcohol. The vapor causes coughing, irritation of the mucous membranes and eyes; and the liquid irritates the skin. Swallowed, pyridine produces headache, dizziness, drowsiness, and tremor.

PYROCATECHOL [$C_6H_4(OH)_2$], catechol, ortho-dihydroxybenzene, pyrocatechin, or pyrocatechuic acid forms white crystals, which turn brownish in the air. It is a photographic developer, hair dye, and analytical reagent. Supersensitive people suffer from skin irritation upon contact with it. See also **Resorcinol,** and **Hydroquinone.**

RADIUM (Ra) **and THORIUM** (Th) compounds are used in some luminous paints. External burns are caused from a type of X-rays (gamma rays) emitted by these radioactive substances. In ternal burns, ulcers, severe anemia and bone disorders result when alpha and beta rays are given off by radioactive substances after they are deposited, like calcium compounds, in the bones.

RESORCINOL [$C_6H_4(OH)_2$], metadihydroxybenzene, or resorcin forms colorless crystals, which turn brownish pink in the air. It is used in tanning, photographic developers, and in the manufacture of dyestuffs, explosives, and other organic chemicals. Persons especially susceptible to resorcinol suffer from skin irritation. See also **Hydroquinone** and **Pyrocatechol.**

SELENIUM (Se) is used in glazes, pigments, alloys, rubber, photo-electric cells, insecticides; to color glass ruby red; as a catalyst for organic reactions; etc. Selenium also occurs as an impurity in many

sulfide ores, and is a hazard found in treating these ores, such as in electrorefining copper, the metallurgy of silver, and the lead chamber process for sulfuric acid. Garlicky breath is a very characteristic symptom of selenium poisoning; in fact this nonmetal was discovered by Berzelius when his housekeeper complained that he was eating too much horseradish and garlic for lunch, whereas he had actually been working with selenium-bearing copper ores.

HYDROGEN SELENIDE (H_2Se) corresponds in properties and toxicity to hydrogen sulfide. Animals exposed to 6 ppm. (0.02 mg. / liter; 0.02 avoirdupois oz. / 1000 cu. ft.) for 1 hour died within 25 days. **SELENIUM OXYCHLORIDE** ($SeOCl_2$) is an extremely toxic, corrosive liquid which imparts a garlicky odor to breath and perspiration, and gives a coated tongue. Selenium oxychloride is extremely vesicant, producing third degree burns on the skin; if spilled it should be rapidly flushed with quantities of water. Only 0.01 cc. applied to the skin of a rabbit killed within a day.

SEWER GAS can be found in sewers, sewage disposal plants, cesspools and other locations where putrifying organic material is present. This gas is deadly in small concentrations as it contains poisonous gases having a high toxicity. Hydrogen sulfide, one of the most important and deadly gases present, has the odor of rotten eggs, and a toxicity rating almost as great as cyanide. Where as little as 0.1% concentration is present immediate unconsciousness results, and unless the victim is removed at once from the contaminated atmosphere and given artificial respiration, death will result.

There is also a deficiency of oxygen; and, in addition, there are inflammable gases present that are capable of exploding. Whenever a leak of sewage occurs in a confined area or space the hazard of explosion is possible; and for this reason flame should be avoided.

A deficiency of oxygen is present because accompanying gases being heavier displace it. When this condition arises the victim has a feeling of lightheadedness and weakness before collapse. Under these conditions a self-contained breathing apparatus is required inasmuch as the canister-type respirator cannot be used when there is a lack of oxygen.

SMOKES and GASES FROM FIRE are responsible for many deaths in industrial fires. Approximately 2000 persons are injured or killed each year in such fires; the majority of these deaths result from smoke and gases. Often the gases reach the victims before the flames and heat.

Gases given off by many burning substances are highly toxic and deadly. On May 15, 1929, there were 125 persons killed in the Cleveland Hospital fire. Most of the victims died from inhaling the gases from burning nitrocellulose X-ray films: gases that were a mixture of carbon dioxide, pyroligneous acid, carbon monoxide, hydrocyanic acid, nitrogen oxide fumes, etc., the latter particularly in this instance from the burning nitrate film.

The poisoning resulting from smokes and gases from burning wood is primarily due to carbon monoxide. But other factors should also be considered: as for instance the fact that carbon dioxide always present in the fire gases stimulates respiration, and thereby increases the inhalation of other gases.

SULFUR, CHLORINATED (S_2Cl_2), sulfur monochloride, sulfur chloride, or sulfur subchloride is a reddish-yellow fuming solvent for oils and fats; also used in printers inks, varnishes, cements, as a rubber vulcanizer, for hardening wood, and as an insecticide. **THIONYL CHLORIDE** ($SOCl_2$) or sulfurous oxychloride is a colorless suffocating, fuming liquid. **SULFURYL CHLORIDE** (SO_2Cl_2) is a colorless, very pungent liquid used for preparing chlorosulfonates; mixed with war gases it forms heavy smoke on contact with the moisture of the air. All three of the above chlorinated sulfur compounds irritate the membranes of the nose, mouth, and particularly the eyes (lachrymators); their poisonous properties are possibly due to their hydrolysis to form sulfur dioxide and hydrochloric acid.

SULFUR DIOXIDE (SO_2) is used in sulfuric acid manufacture, bleaching as in the fruit and paper industries, refrigeration, fumigation; etc. Sulfur dioxide from smelting sulfide ores and from burning coal containing sulfur compounds pollutes the air in the form of sulfuric acid, to which SO_2 is converted by oxidation. Symptoms are irritation of the upper respiratory tract, which some-

times causes pneumonia. Because of its sharp, biting odor it is more warning than some other gases. Sixty minutes' exposure to 500 ppm. (1.3 mg. / liter) is dangerous; safe working concentrations for several hours is less than 10 ppm. (New Jersey and Massachusetts).

SULFUR TRIOXIDE (SO_3) is a colorless liquid that solidifies into needlelike crystals a little below room temperature. It fumes strongly in the air. Sulfur trioxide, formed in the contact process, is dissolved in dilute sulfuric acid to form concentrated acid, or in still greater concentration to form fuming sulfuric acid (oleum). Ten ppm. of SO_3 (0.033 mg. / liter) will kill animals in a few minutes.

TELLURIUM (Te) is used in coloring glass and china; in toning silver prints; to toughen rubber, and to harden lead. It is a brittle, shiny nonmetal. Tellurium fumes affect like arsenic, but not so seriously. It produces a garliclike odor on the breath; dry, itching skin; metallic taste; nausea, vomiting, and constipation.

TETRACHLOROETHANE. See acetylene tetrachloride.

TETRACHLOROETHYLENE ($Cl_2C{=}CCl_2$), carbon dichloride, or perchlorethylene is a colorless, non-inflammable liquid with an ethereal odor; it is a commercial degreaser, solvent, and dry cleaner, similar in action to carbon tetrachloride. Tetrachloroethylene causes irritation of the eyes; nausea, vomiting, faintness, dizziness, headache, and visual disturbances.

TETRALIN ($C_{10}H_{12}$) or tetrahydronaphthalene is a colorless, pungent solvent for fats, waxes, and oils; it is used for degreasing textiles, and in dry cleaning. Some slight skin irritation and systemic poisoning is claimed from its use.

THALLIUM (Tl) is present as an impurity in flue dusts in the lead-chamber process; also thallium compounds are used in rat poisons and ant buttons, and in glass. They cause loss of hair, cramps, diarrhea, heart failure, pains in the limbs and severe eye affections.

TIN (Sn) is relatively harmless: guinea pigs tolerated 3 ppm. for months without illness. **TIN TETRACHLORIDE** ($SnCl_4$), on the other hand, used for weighting silk and as a mordant in dyeing,

may have toxic effect. **TIN SALTS** ($SnCl_2.2H_2O$), tin crystals, or stannous chloride are used as a wool mordant, for weighting silk, and in calico printing.

TOLUENE ($C_6H_5CH_3$), toluol, methylbenzene, or phenyl methane is a colorless liquid with a characteristic benzenelike odor. It is obtained from coal tar, but lately in huge tonnages by the catalytic cyclicization of petroleum. Toluene is used in manufacturing explosives (TNT) and other organic chemicals; as a solvent, as for extracting active principles from plants; and as a diluent for cellulose esters. Two hundred ppm. toluene is considered maximum allowable concentration in New Jersey and Massachusetts. Toluene causes headaches, vertigo, staggering gait, convulsions, and loss of consciousness.

TOLUIDINE, ortho ($CH_3C_6H_4NH_2$), 2-aminotoluene, 2-methylaniline, or orthomethylaniline, a light yellow liquid darkening to reddish in the air, is an intermediate in manufacturing dyes, explosives, and other organic chemicals; in printing textiles blue black. Vapors produce headache, weakness, difficult breathing, cyanosis, convulsions, and diarrhea. It is about as toxic as aniline, but is not absorbed so easily through the skin. Some slight injury has been reported from an exposure of several hours at 10 ppm. (0.04 mg. / liter; 0.04 avoirdupois oz. / 1000 cu. ft.).

TRICHLOROETHYLENE ($CICH—CCl_2$), a colorless solvent with a chloroformlike odor, is used as a degreasing agent and dry cleaner, also in rubber, paints, varnishes, and insecticides. It does not burn at ordinary temperatures but forms phosgene in contact with metals at high temperatures. It is said to be 13 times more active than chloroform as an analgesic. With moisture, trichloroethylene gradually decomposes, acquiring an acid reaction. Experiments on its toxicity to animals give varying results, in general revealing a toxicity about equal to that of carbon tetrachloride. A working concentration of under 200 ppm. is allowed in New Jersey and Massachusetts.

Symptoms. Breathed or absorbed through the skin it causes nausea and vomiting; headache; sense of confusion; irritation of the

eyes, nose, and throat; nervousness; pallor; weakness and weak pulse; unconsciousness and death.

Treatment. Summon a physician at once. Remove to fresh air, give a stimulant such as hot coffee or tea; keep the patient warm and quiet.

TRICRESYL PHOSPHATE, ortho [$(CH_3C_6H_4)_3PO_4$], tri-o-cresyl phosphate, or ortho-toluyl-phosphate is an odorless, yellowish oily liquid used as a plasticizer for pyroxylin, for varnishes, and in making celluloid. Because of its low volatility tricresyl phosphate is not especially poisonous, but less than 1 g. per pound of body weight will cause stomach disorder, then apparent temporary relief, and finally soreness of the muscles and paralysis of the arms and legs. When swallowed it causes ginger jake paralysis.

TRINITROPHENOL [$HOC_6H_2(NO_2)_3$]. See **Picric Acid,** Chapter 3.

TRINITROTOLUENE [$CH_3C_6H_2(NO_2)_3$] or TNT is a crystalline explosive, which stains the skin and hair of workers a deep yellow. Absorbed through the skin, or inhaled, it produces cyanosis, blue "lead line" on the gums, and often jaundice.

TURPENTINE ($C_{10}H_{16}$). See Chapter 3.

VANADIUM (V) is a metal used in stainless steels, along with chromium. Some vanadium compounds are used in the nonferrous, glass, ceramic, and color industries; and vanadium pentoxide is a catalyst for the sulfuric acid contact process. No accumulative affect of vanadium dust was found; high concentrations produce irritation of the respiratory tract, coughing, hemorrhage, anemia, nausea and vomiting, and later nervousness and dizziness.

VINYL CHLORIDE (CH_2—$CHCl$) or chloroethylene is a colorless gas with an ethereal odor, polymerized in manufacturing vinyl-type plastics. It produces loss of locomotion, rapid and later slow breathing, and finally coma. Vinyl chloride is more of a fire hazard than a poison, for the dizziness that it causes is a warning signal. It is less toxic than carbon tetrachloride: 100,000 ppm. of vinyl chlo-

ride (256 mg. / liter; 256 avoirdupois oz. / 1000 cu. ft.) for an hour may cause death; 5000 ppm. is relatively safe for an eight-hour exposure (Dalla Valle).

XYLENE [$C_6H_4(CH_3)_2$], dimethylbenzene, or xylol is a colorless solvent obtained from coal tar. It is used in manufacturing dyes and organic chemicals; in miscroscope technique; and for sterilizing catgut. The lower volatility of xylene makes it less dangerous than benzene, but 100 ppm. of xylene (0.43 mg. / liter; 0.43 avoirdupois oz. / 1000 cu. ft.) may produce illness; allowable concentration in New Jersey and Massachusetts is 200 ppm.

ZINC (Zn) dust or oxide powder is about as poisonous as other metal dusts but not more so. See **Metallic Fumes.**

CHAPTER 6

Poisoning from Foods, Plants, Snakes and Spiders

FOOD POISONING

Occasionally people are poisoned by toxic substances that are present in different kinds of food. Poisoning may occur:

1. From materials introduced accidentally or intentionally into the food during its preparation.
2. From bacteria and animal parasites introduced into the system by the food eaten.
3. From poisons present in or developed by certain animal or vegetable foods.
4. From toxins produced by bacteria in the food before it is ingested. Food poisoning can effect more men and cause more incapacitation in a short time than any other disease condition. The symptoms usually occur within from 4 to 6 hours, may occur within 2 to 24 hours, and occasionally are delayed 72 hours.

Types of Foods That Cause Poisoning. Some of the more common types of foods that have caused poisoning are:

Canned Goods.

Fish and Shell Fish. Crabs and lobsters cause the majority of poisonings in this type.

Meat. The infection of meat may occur before, or after, the death of the animal. Meat from healthy animals may become infected during the process of slaughtering and cutting up the animal if the hands

or instruments used have already become infected from diseased animals. It may be carried by rats, mice, flies, and cockroaches from diseased meat to healthy meat. It may be transmitted by healthy meat coming in contact with diseased meat. Or it might be that the infection was limited only to a portion of the intestinal tract, but was transmitted to other parts by rupturing during the cutting up of the carcass.

Meat Mixtures. Hash, meat loaf, meat pie, chicken salad, hamburger, etc.

Milk and Milk products. Cream puffs, custards, and cream pies.

Mushrooms. The toadstool variety usually mistaken for the edible mushroom. See page 81.

Potatoes. Usually caused from the potato after cooking.

Ripe Olives.

Symptoms. Abdominal pains are usually the first sign, and may be griping and severe; nausea and vomiting, diarrhea, headache, chill, faintness, muscular weakness, moderate rise in temperature, restlessness, and skin rashes often occur.

Treatment. Summon a physician immediately. Empty the stomach with an emetic such as mustard in water and continue until the evacuated liquid is clear; follow with a large dose of Epsom salts in water. Following this treatment give castor oil (2 tablespoonfuls to an adult; 2 teaspoonfuls to a child). Follow with a stimulant such as hot coffee or tea, or aromatic spirits of ammonia (1 teaspoonful in ½ glass of water). Keep patient warm and quiet.

Poison Ivy—Poison Oak—Poison Sumac

Poison ivy, poison oak, and poison sumac are all poisonous members of the sumac species (genus *Rhus*). All three cause a severe inflammation of the skin in susceptible persons. Some persons are not poisoned by ordinary handling of the plant; others may be extremely susceptible. No one is completely immune, even though one person may not be so sensitive as others. He may, time after time, handle the plant without a reaction, and then suddenly fall a victim to the poison. The skin reaction is more likely to occur when the skin is wet or damp with perspiration.

Poison Ivy, found in the Eastern States, may grow as a bush, a vine, or a shrub. The leaves are shiny, rather broad, have irregularly cut edges, and are arranged in characteristic groups of three leaves to a stalk; two leaves with short stems are opposite each other on the stalk, and the third leaf is at the end of the stalk.

Poison Oak, found in the United States on the Pacific Coast in greater quantity than in the East, grows as a climbing vine as well as in bush form. The leaves are similar to oak leaves and arranged also in groups of three leaves.

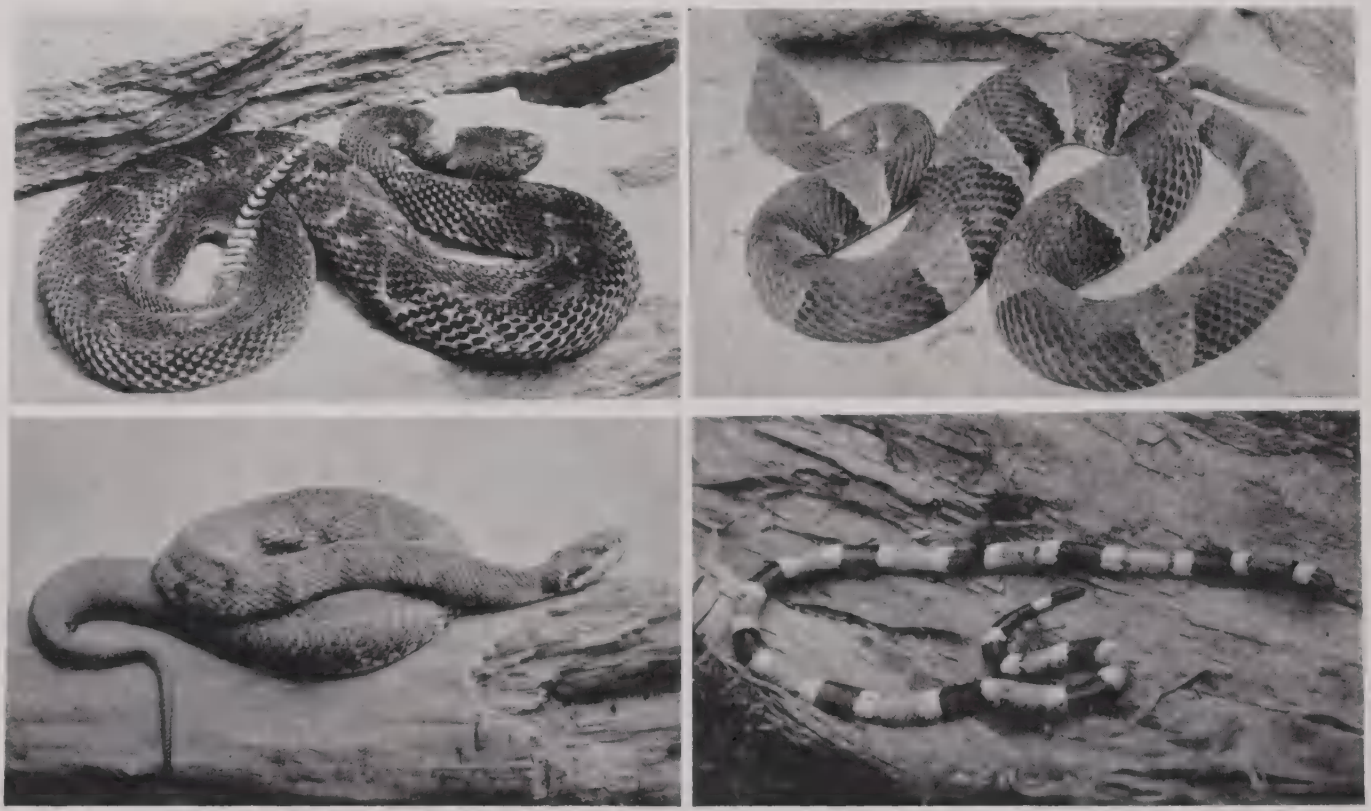
Poison Sumac is found in the United States mainly along the Atlantic Coast in swamps and wet ground in the form of a shrub or small tree. Other names it is known by are: poison elder, poison ash, poison dogwood, and swamp sumac. The leaves are arranged in pairs and opposite each other along a stem with a single leaf at the end of the stem. The berries, resembling mistletoe, accompanying the plant are in loose clusters from three to eight inches in length, and are waxy and cream colored and remain throughout the winter. The berries of the nonpoisonous sumac are rusty red in color.

Poisoning from These Plants. The poisonous substance of each of the three plants causing the skin reaction is oily and related to phenol (carbolic acid). It is found in all parts of the plant, and is present in the milky sap. Contamination is caused by handling the plant or any object that has been in contact with it. The evaporation of the poisonous substance is so slow that a person may be poisoned from an object put away months previously. If the plant is being burned, the poison is carried in the smoke; and contact with the smoke will cause poisoning.

The U.S. Public Health Service (Bulletin August 1945) has developed two protective ointments; one is less oily. They contain sodium perborate and oxidizing agents. The ointment is applied generously on the skin where the worker may contact the ivy. The ointment is washed off and new applications made several times during the day. Authorities disagree on the complete success of this ointment.

About fifteen minutes is taken for the poison to penetrate the skin. Poisoning may be prevented if the skin is thoroughly washed before

Top, left—Poison Ivy. (*Courtesy of American Museum Natural History.*) *Top, right*—Poison Sumac. (*Courtesy of Brooklyn Botanic Garden.*) *Bottom*—Poison Oak. (*Courtesy of Brooklyn Botanic Garden.*)



Upper left—Rattlesnake. *Upper right*—Copperhead. *Lower left*—Cottonmouth Moccasin. *Lower right*—Coral Snake. (*Courtesy of American Museum of Natural History.*)

absorption occurs. When the washing is completed apply a rubbing alcohol. It has been found that first a washing with a solution of trisodium phosphate (Oakite Cleaning Powder, 1 teaspoonful to a quart of water) followed by a thorough soap wash gives better results than just a soap wash.

Symptoms. Redness, burning, itching, and swelling occur in from a few hours to a few days. Symptoms appear faster to a person allergic to poison ivy than to one not so susceptible. Blisters follow; and larger blisters develop by small ones uniting. A watery fluid is discharged when the blisters are broken; but contrary to general belief this fluid will not spread the contamination.

Treatment. When the area poisoned is large or severe see a physician immediately. When the rash is first noticed wash with soap and water and then with a 70% alcohol. Several treatments may be tried for relief:

1. Swab with a 5% ferric chloride solution. If it must be applied near the eyes dilute this solution about one-half. Lemon juice will remove the yellow stain left by this solution.
2. Apply a wet dressing of baking soda and cold water or strong Epsom salts and cold water.
3. Make a thick paste of soap and water and apply on a sterile dressing to the area. Leave on overnight.
4. Large blisters are punctured at the sides with a sterile needle, and the fluid gently pressed out with a sterile dressing or gauze. Apply a dressing soaked in baking soda, or moisten the area with a 5% solution of potassium permanganate.

Poisonous Snakes

There are more than two thousand kinds of snakes in the world; of these somewhat over two hundred species and subspecies inhabit the United States. The weights and sizes of snakes range from a few ounces for those about six inches in length, to more than three hundred pounds for snakes as long as thirty feet. Less than 15% of all snakes possess fangs capable of injecting poison, of which slightly over half will kill human beings. Contrary to general belief, most

snakes are actually of value to man, since they feed principally on destructive, obnoxious, and disease-spreading insects and rodents.

Only the poisonous varieties of snakes found in the United States will be considered here. These are easily identified by distinctive markings. They may be classified as follows:

The Pit-Vipers. (1) *The rattlesnake;* it has a rattle at the end of its tail. (2) *The copperhead;* it is marked with dark saddles, shaped like hour-glasses, across its back; (3) *The cottonmouth water moccasin;* it is dark in color; the top of its head is flat, and the sides of the face are also flat; where the top joins the sides there is a noticeable ridge running from the tip of the nose to behind the eyes; and the eyes are protected by scales. Nonpoisonous water snakes, on the other hand, do not possess these distinctive features, the flat surfaces, the eye shields, or the ridges.

The Coral Snake. This snake is found only in the South. It is the smallest of these poisonous snakes, seldom larger than thirty inches in length, with a head not fatter than the body. It has black and red bands, divided by yellow bands, completely encircling the body.

Snake Bites. The venom of these snakes is amber-colored; it is produced by the upper salivary glands, and injected into the body by means of two hollow teeth of the upper jaw. These teeth are folded back into the mouth when the mouth is closed, but when the snake bites, the teeth (fangs) are thrust forward. Snake bites, though not common, occur with sufficient frequency to demand care for those who roam the fields, the woods, and the mountains.

Symptoms. A sharp burning pain followed by a discoloration and swelling; and as the poison dilutes and passes into surrounding tissues the swelling advances up the limb toward the heart. The arms and legs at times swell to twice their normal size. Two fang marks are sometimes present, although if the bite is imperfect only two scratches may be shown.

Treatment. Summon a physician. Use no alcoholic drinks; do not attempt to cauterize the wounds; do not apply potassium perman-

Head of poisonous snake showing poison apparatus. *(Courtesy of American Museum of Natural History, N. Y.)*

Davis snake-bite kit.

ganate. Apply a constricting band of some type a few inches above the bite to slow down the circulation of the blood. Tighten sufficiently to stop the return of venous blood but not the flow of blood in the arteries. Release every ten minutes for about ten seconds, and then tighten again. Make deep X-shaped cuts ½ inch long through the skin at the points where the fangs entered the skin. Allow the blood to flow from these cuts, as this will eliminate much of the venom. Apply suction for 20 minutes every hour for several hours. During intervals between suction, cover with sterile dressings which have been wetted with a strong solution of table salt or Epsom salts in water.

Treatment by the Physician. The physician may give Antivenin. The North American Anti Snake Bite Serum (L 10A "Lyovac" Antivenin Nearctic Crotalidae) is supplied with (1) a "Vacule" ampul, containing 15 cc. of restored serum; (2) a syringe containing 15 cc. of distilled water; (3) a 1 cc. vial of Normal Horse serum (diluted 1:10), as test and desensitizing material; and (4) a first-aid ampul of iodine solution. Sedatives such as aspirin or morphine, or minor doses of a barbiturate, may be given for the relief of pain and nervousness. Aromatic spirits of ammonia or strychnine are of value for collapse. If the individual is severely poisoned, great relief is likely to be experienced from infusion with a large amount of physiological saline or even better a transfusion of whole blood. The effects of this treatment may be the difference between life and death.

The Black Widow Spider

The "black widow" spider belongs to the arachnid family Theridiidae, and has many synonyms, among them are: "hourglass spider," "shoebutton spider," "Pokomoo," "cul rouge," and many other colloquial names.

The black widow spider in its natural habitat is found in dark locations, such as vacant rat holes, under logs and stones, in stumps of trees, and in wood piles. It makes its web in structures ranging from outer toilets, to and including garages, chicken houses, barns, cellars, and in the home itself.

Generally the female, responsible for the bite, is not aggressive

unless bothered or very hungry. When guarding the egg sac the female is likely to bite.

The matured female is glossy black to sepia, and covered with short hairs. The characteristic crimson hourglass marking on the underside of the abdomen varies from the distinct hourglass design to one comprising two or more distinct triangles, or to an irregular longitudinal marking. The abdomen is globose and resembles a shoe button. See illustration page 80.

When the web is completed and established, the female spends the remainder of her days feeding on the victims caught in her web and guarding her egg sacs. The spider approaches the prey backwards, and engulfs her victim in a freshly spun strand, using either one or both hind legs to tie down the thrashing appendages. If she finds her prey hard to control, she ejects from her spinnerets large viscous droplets, which dry rapidly, making escape impossible. About this time she administers a lethal bite. After being bitten, the victim struggles violently, and within a few minutes dies. The body fluid of the victim is then sucked by the spider in her leisure time. Upon completion of the meal all points of attachment between the web and the victim are cut loose allowing it to drop from the web.

The spider is not usually aggressive toward human beings unless hungry, agitated, or disturbed while guarding the egg sac.

Symptoms. The bite is not always felt (resembles a pin prick); however, a slight swelling (local) and two tiny red spots may appear. Pain, usually in the region of the bite, is felt almost at once and increases in intensity, reaching its maximum in 1 to 3 hours and continuing for approximately 12 to 48 hours. Stomach muscles become rigid and boardlike; there is a slight rise in body temperature, increased blood pressure, profuse perspiration, nausea and vomiting, chills and pallor.

Treatment. Send for a physician. Apply tincture of iodine at the site of bite to prevent secondary infection; keep the patient warm and quiet. Professional treatment for the bite of the black widow spider is mainly the use of opiates, hydrotherapy, and other measures to alleviate the pain.

CHAPTER 7

Special Techniques

In addition to the chemical treatments for poisons, there are several devices and techniques that may be called into use in an emergency. Those taken up in this chapter are: (1) artificial respiration, (2) the gas mask, (3) the inhalator, and (4) treatment for shock.

ARTIFICIAL RESPIRATION
(Schafer Prone Pressure Method)

Never assume death is present because signs of life are absent. Certain accidents cause cessation of breathing; death results a short time after breathing stops.

Breathing can be carried on for the victim by alternately compressing the lungs and releasing the pressure, thereby causing a flow of air into and out of the lungs. This method of aid to the victim is known as artificial respiration.

Many such methods have been used in the past years, and many types of artificial respiration are used today; but the method that is universally used and accepted by most organizations in the safety field is the Schafer Prone Pressure Method. Since its introduction into this country in 1907, the Schafer method has never changed. Certain alterations were made to increase effectiveness and operation, but the main principle is the same.

Standard Technique

1. Place the victim on his belly, extend one arm over his head with a slight bend at the elbow. The other arm is bent at the elbow with the face of the victim turned outward toward the fingers and

resting on the back of the hand and fingers of that arm. The nose and mouth should be free for breathing (Figure A).

2. Kneel and straddle the victim's thigh or thighs with your knees placed at a distance which allows your arms to assume about a 45° angle as illustrated in Figure B. Place the palms of your hands on the small of the victim's back with the little fingers just touching the lowest ribs. The tips of your fingers are just beyond sight.

3. Keeping the elbows locked and the arms straight, slowly swing forward so that the weight of your body is brought gradually upon the victim. Swing forward until your shoulders are almost over the heels of your hands. This should take about two seconds (Figure C).

4. When the top of the forward swing is reached as illustrated in Figure C, immediately swing backward to position in Figure D to begin another complete movement of compression and release, the start of which is as illustrated in Figure B. The complete movement should take about four or five seconds.

Artificial respiration should not be interrupted once it has been started and should be continued until natural breathing occurs or rigor mortis sets in. No time should be lost in its start, and while it is being applied, an assistant should send for a phyician, loosen tight clothing, remove any obstruction in the mouth that would retard free breathing, place blankets under and over the patient to conserve body heat, and apply wrapped heat applications under the blankets because unconscious people lose body heat very rapidly. Any work being done by the assistant should be done without interrupting artificial respiration.

The victim should be kept warm, quiet and lying down upon recovery to avoid a strain on the heart. At this time he may be given a stimulant such as hot coffee or tea, or 1 teaspoonful of aromatic spirits of ammonia in ½ glass of water.

The Gas Mask

When the atmosphere is contaminated, a gas mask of some type must be worn for protection. Here we shall discuss the canister-type mask, as it is the most common mask found in emergency work today.

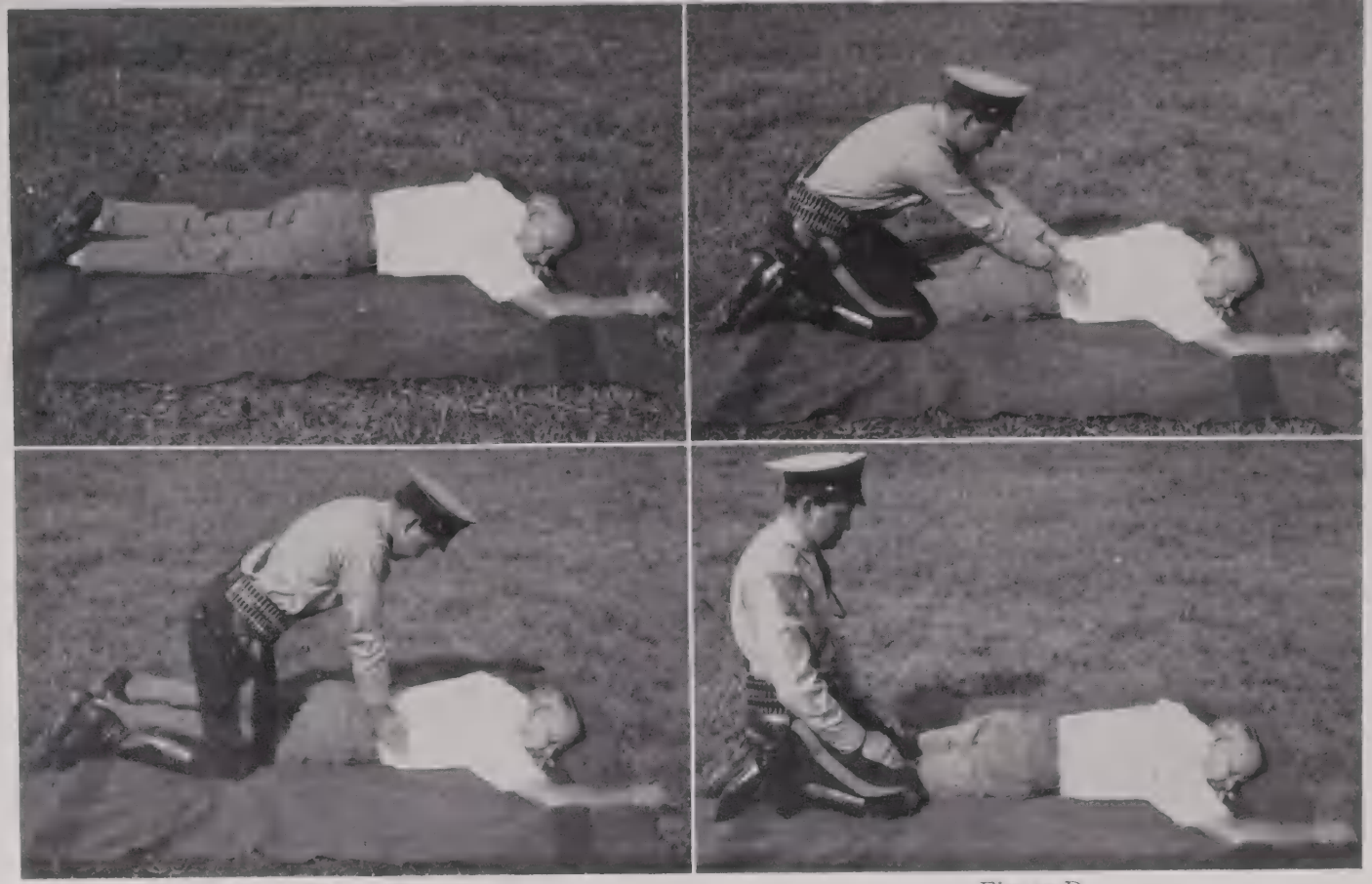


Figure C

Figure D

Upper left—Position of patient. *Upper right*—Position of operator at start of Artificial Respiration. *Lower left*—Position of operator at peak of upward swing. *Lower right*—Position of operator after release, before assuming position, upper right.

Purpose. The purpose of a gas mask or respirator is to remove chemical agents from the air we breathe, thereby protecting the face, eyes, and lungs from injury by toxic or irritating gases, vapors, or smokes. Many of these chemical agents are deadly in a few seconds, even though the concentration of the gas is low.

Construction. The complete canister gas mask consists of three principal parts: the facepiece assembly, the canister, and the carrier.

1. *The facepiece* assembly consists of an adjustable rubber or elastic headharness, a rubber or rubberized fabric facepiece containing eye pieces, a rubber disc outlet valve, a hose connection, and a connecting hose.

2. *The canister* supplied with the mask is done so only after it is known what chemicals must be encountered. Canisters giving protection against one type of gas will be inefficient against another type. There are canisters available for every known toxic vapor, fume, or smoke. An all-service type canister can be secured that will give protection for a short time against them all, including carbon monoxide. The canister consists of a hose connection, one or two inlet valves, depending upon the type canister used, and chemicals for purifying the air to be breathed.

3. *The carrier* can be a metal case, a composition case, or a canvas pouch or sack containing straps and buckles for attachment to the body of the wearer.

The mask is constructed to filter the air before it enters the facepiece. On inhalation the contaminated air first passes through the canister containing a filtration system. The filtration system comprises a mechanical filter and a chemical filter. The mechanical filter frees the solid and liquid particles from the air, and the chemical filter absorbs and neutralizes the toxic and irritating gases and vapors. After the air has been purified by this process it enters the facepiece to be drawn into the wearer's lungs. Upon exhalation, the air is expelled from the mask through the outlet valve.

The protection given by a canister gas mask is due primarily to the canister; the other components of the mask only prevent the air from entering the facepiece by any other route. No canister gives protection indefinitely, as the life of the canister is dependent upon

the quantity of gas it is capable of filtering out of the air. There must also be sufficient oxygen present to support life. If a condition arises where there is not enough oxygen present, a self-contained oxygen breathing apparatus must be used. Here the oxygen is carried in tanks on the wearer's back. This type of apparatus is used exclusively in mine rescue work where carbon monoxide and methane gases prevail, or where deficient atmospheres are encountered.

Fitting the Mask. The adjusting and fitting of the mask should be done when it is first received, so that it will be ready for instant use and give full protection in the event that it is necessary to put it on in a hurry. Gas masks are individual equipment and should be used by no one but the owner. This prevents spreading colds, sickness, and contamination. Also, because it is fitted for one person and not the other, and the time may arise when promptness and a perfectly fitted mask will prevent the wearer from being another casualty.

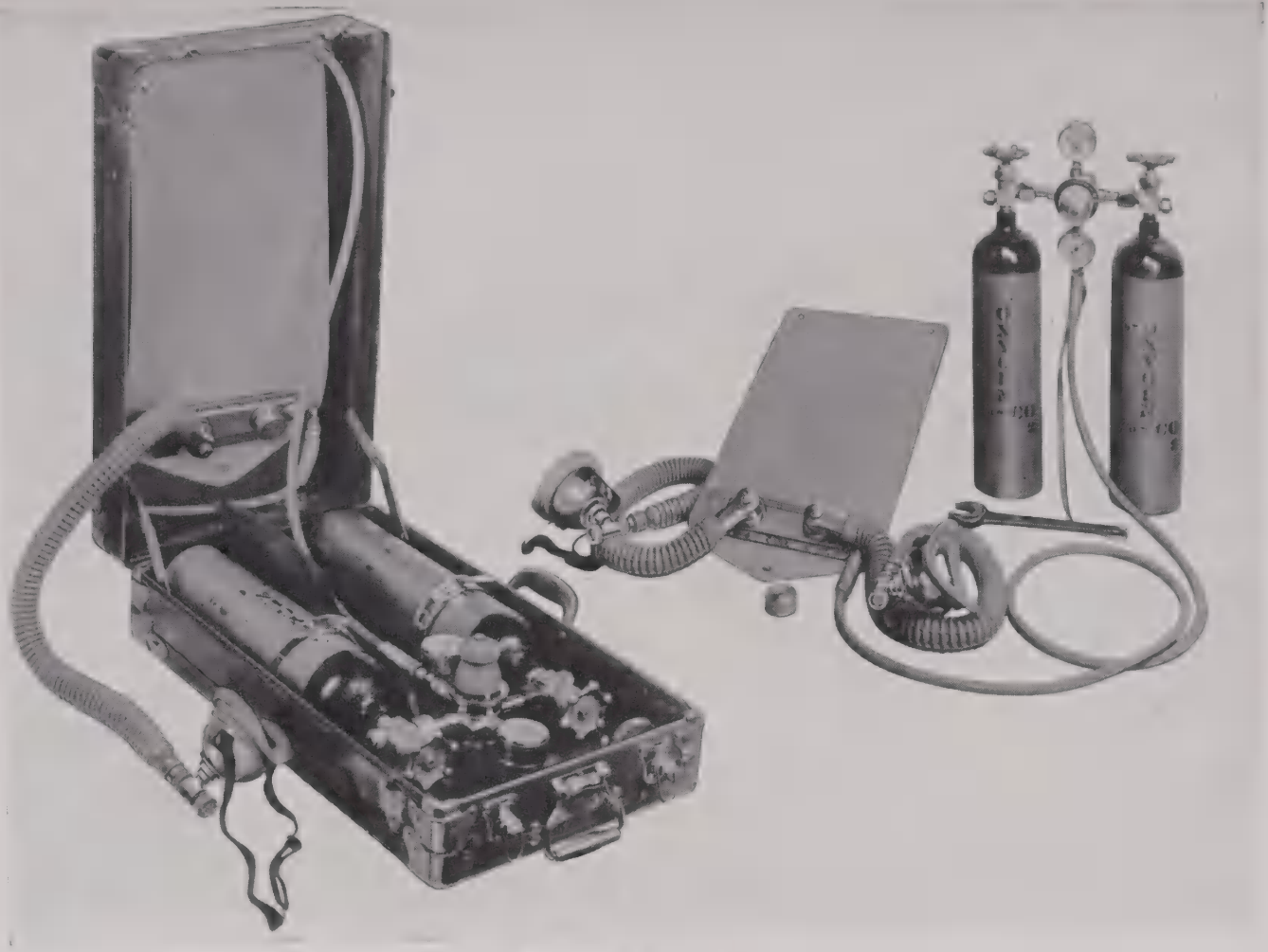
Putting on the Mask. Place the thumbs on the inner side of the mask just under the head harness, with the fingers supporting on the outside of the facepiece. Thrust the chin forward and place the chin into the chin indentation of the mask. The head harness is then brought over the head with the fingers, and the straps of the head harness straightened at the same time. The facepiece is now smoothed out, beginning at the chin, to eliminate creases and channels. Finally check the mask to insure its proper fit.

Checking the Mask. Place the palm of the hand over the intake valve on the bottom side of the canister, and inhale. If the mask is properly fitted it will collapse against the face.

Safety Line. A good precaution, wherever practical, is to attach a safety line to the person making a rescue; so that if he must be reached quickly the line may be followed into the gassed area.

The Inhalator

It has been proved through long experience that an administration of a mixture of 7% carbon dioxide for stimulation, and 93% oxygen for ventilation of the respiratory system, speeds recovery whenever the lungs have been hindered in their proper functioning. An inhala-



Davis Inhalator.

M.S.A. Inhalator.

tor provides this gaseous mixture when artificial respiration is being applied or when the victim is breathing by his own effort.

Inhalator Instructions

1. Open the valve at the top of the cylinder and make sure the pressure gage registers the amount of oxygen remaining in the tank.

2. Next open the low pressure regulating valve until the breathing bag becomes partly inflated. It is not necessary to fill the bag completely as it will be difficult to see the bag breathe. About 50% inflation will give best results. The reducing valve is opened or closed according to the individual's lung capacity. **Do not allow the bag to collapse.**

3. Make sure that the facepiece fits the victim's face firmly, covering the nose and mouth. This insures a constant concentration of oxygen at the points of inhalation. When the reducing valve is completely open and the victim takes enough air to collapse the bag, the air inlet valve or mica disc on the facepiece automatically opens, allowing fresh air to complete the inhalation.

4. After the patient has started to breathe, about twenty minutes use of the inhalator is usually all that is necessary.

5. When the pressure gage shows zero, it is time to replace the cylinder or change to another cylinder if the apparatus is of the two-tank type. This should be done without stopping the flow of carbogen. First close the valve at the head of the empty cylinder and the one between the cylinder and the reducing valve. Then open the valve at the head of the new cylinder and the valve between the new cylinder and the reducing valve and the inhalator will continue its normal operation.

NOTE. After using, sterilize the facepiece with a Lysol solution. Do not use steam or boiling water.

TREATMENT FOR SHOCK

Shock occurs more or less from all injuries. The stability of the nervous system is an important factor in determining the degree of shock present. What might be a mild case in one individual may be a severe case in another. This condition may vary from a slight feeling of faintness to a condition of collapse, in which the forces of the human body are so exhausted that death may result.

The injury sustained is the primary cause of shock; and in many cases shock can be overcome by rest and retaining body heat. However, there are cases of shock resulting from burns, abdominal injuries, severe crushing injuries and poisoning from strong acids and alkalies, where shock develops rapidly and endangers life. In these cases it is good emergency treatment to treat for shock while the injury is being taken care of.

Symptoms. When shock occurs there is a stagnation of blood in the region of the abdomen, which results in the following condition:

The pulse is rapid, weak, and irregular.

The face is pale, and a cold sweat is present, especially noticeable on the forehead.

The body is cold and often a severe chill develops, frequently accompanied by nausea and vomiting.

The patient is weak, listless, and dull and takes little interest in what occurs around him.

He may lapse into complete unconsciousness.

Treatment. The purpose of shock treatment is to bring the accumulated blood from the abdominal region back into circulation, to bring the proper blood supply back to the brain and to the surface of the body where it is vitally needed, and to administer proper stimulation. Important procedures to accomplish these results are:

Summon a physician.

Wrap completely in blankets. At least four thicknesses of blankets beneath the patient is important and necessary.

Place the patient on his back with the head low. This can be accomplished by raising the foot of the bed or object on which he is lying. If the person is on the ground, place something under the feet and legs.

If the victim is conscious, and only if he is conscious, give him a stimulant such as hot coffee or tea.

We must bear in mind that the treatment of shock is often just as important as the injury itself. Since shock can result in death, it is important that a physician be summoned as soon as possible.

Appendix

GLOSSARY

This glossary has been compiled of words found in this book; many of the words ordinarily are familiar only to the physician. Their arrangement alphabetically will assist you in familiarizing yourself with and understanding better all the information in this manual. In many cases the definitions are in the restricted sense as applied to the field of poisons; for their wider meanings see any standard dictionary.

Abdomen—the lower part of the belly.

Abortion—miscarriage; failure to mature.

Absorb—to drink in; to suck up.

Absorbents—substances that increase the absorption of diseased tissue.

Absorption—act of absorbing.

Accidental—happening unexpectedly, or unintentionally.

Acetates—salts formed by the reaction of acetic acid and a base.

Acid—bitter; a compound containing hydrogen replaceable by metals.

Acrid—sharp; having a biting taste; pungent.

Acute—attended with symptoms of some degree of severity and coming speedily to a crisis.

Addict—one who is given to taking drugs habitually.

Addiction—the act of taking drugs habitually.

Administer—to apply; to tender.

Administration—the act of applying.

Adrenalin—an extract from the secretion of the suprarenal glands and used as a stimulant or astringent.

Affinity—attraction between bodies to form compounds.

Afterdamp—carbonic acid gas accumulated in mines, etc.

Alimentary canal—the tube from mouth to anus, through which food passes.

Alkali—acid-destroying compounds; they turn litmus blue.

Alkaline—having the qualities of an alkali.

Alkaloid—an organic nitrogen base, vegetable origin, usually toxic in effect.

Alloys—compounds or mixtures of two or more elements, one of which must be a metal, e.g. brass from copper and zinc.

Analgesic—a substance that relieves pain.

Analogous—presenting some resemblance.

Analysis—decomposition; the resolution of anything into its constituent elements.

Analytical—resolving into constituent parts; pertaining to analysis.

Anatomical—belonging to anatomy, that is, to the science of the structure of animals or of the art of dissecting animals.

Anemia—a deficiency of the blood causing ill health, paleness.

Anesthetic—producing loss of feeling or insensibility to pain; a substance such as ether or chloroform.

Aniline—a substance furnishing brilliant dyes.

Antacids—substances that neutralize acids.

Antidote—a counterpoison; that which counteracts anything noxious. See page 25.

Antiemetics—substances used to check vomiting.

Antipyretics—subtances that reduce fever.

Antiseptics—substances that check the growth of bacteria.

Antispasmodics—substances that lessen convulsions and muscle contraction.

Antizymotics—substances that check germ action.

Aperients—substances that produce bowel movements.

Apoplexy—a condition caused by a sudden stroke, usually effusion on the brain.

Aqueous—of the nature of water, made from water.

Artificial respiration—a method of giving breath to a person manually.

Asphyxia—suspended animation; cessation of the motions of the heart as in drowning or suffocation.

Astringents—medicines that cause contraction of the muscle fibers and hardens tissue.

Avoir.—the abbreviation used in this book for avoirdupois weight.

Bacillus—microscopic, rodlike germs capable of causing various ills.

Bacteria—a widely distributed group of microscopic one-celled vegetable organisms, living on dead or live organic matter and causing a great variety of processes and conditions affecting animal and vegetable life, as decay, and in some cases disease.

Bile—a greenish, bitter fluid secreted by the liver; gall.

Bitters—substances that increase the appetite and flow of gastric juice.

Bleaching—act or art of whitening, especially by chemical processes.

Brittle—fragile; easily broken.

Bromides—compounds of bromine and some metal as potassium bromide.

Bronchitis—inflammation of the mucous membranes of the bronchial tubes.

Bronchopneumonia—a term applied to inflammation of the lungs.

Cachexia—a depraved condition of general nutrition.

Calibrations—corrections, as of the errors in a thermometer.

Capsules—a small envelope of gelatin inclosing medicine.

Carbonaceous—pertaining to; containing or composed of carbon.

Cardiac—pertaining to or affecting the heart.

Cardiac depressant—a heart depressor; that which lessens heart activity and causes the heart to beat more slowly and more weakly.

Cardiac stimulant—increases heart activity and makes it beat faster and stronger.

Catalyst—a chemical which speeds up action without itself changing.

Cathartics—substances that cause bowel movement.

Caustics—substances that have the power gradually to eat away animal tissue by chemical action.

Cauterizing—burning or searing with a hot iron or with some caustic agent, as of a wound, to destroy morbid tissue.

Ceramics—pertaining to pottery; baked substance containing clay.

Cerebral depressants—substances that lessen brain activity. In large doses they induce sleep.

Cerebral stimulants—substances that increase brain activity and make the patient brighter, more talkative, and more active. In large doses they produce hallucinations, convulsions, delirium, etc.

Characteristic—nature of; pertaining to.

Chemical—produced by, or used in operations of chemistry.

Chemical analysis—to unloose; to dissolve; to resolve into its elements through chemical means.

Chokedamp—carbonic acid gas accumulated in mines, etc.

Chronic—continuing for a long time, as a disease.

Cinnabar—red sulfide of mercury.

Circulation—flow of blood from and back to the heart.

Clammy—sticky; moist.

Cluster—a number of things growing together, as grapes; a group.

Colic—a painful disorder in the abdomen.

Colicky—a condition, or resembling a condition, where there is a painful disorder in the abdomen.

Collapse—sudden failure; sudden prostration.

Coma—unconsciousness from which the patient cannot be aroused by external stimulants.

Combustible—capable of taking fire and burning.

Combustion—act of burning.

Components—parts of a mixture; ingredients of a mixture.

Compound—composed of two or more elements.

Compounded—mixed or combined, as of drugs.

Concentrated—increased in strength; to bring to a point or common center.

Concentration—strength, amount of material dissolved; the act of being placed together; close attention.

Constipation—clogging of the bowels.

Constituents—parts of a compound; ingredients of a compound.

Contaminated—soiled; corrupted; polluted; tainted.

Contracted—shrunk; made smaller.
Converted—changed from one state to another.
Convulsants—substances that produce convulsions.
Convulsions—any violent motion or agitation; spasmodic.
Convulsive—a condition of involuntary contraction of the muscles.
Corpuscles—in anatomy, small masses, as red or white corpuscles, in the blood.
Corrosive—any substance that eats away.
Corundum—a very hard mineral substance used in abrasives.
Countenance—features; face.
Counterirritants—substances relieving inflammation in remote tissues and organs.
Crude—raw; in natural state.
Crystal—a substance whose constituent elements have assumed a regular geometric pattern.
Crystalline—resembling crystal; transparent.
Cyanosis—blue discoloration of the skin from lack of oxygen in the blood.
Cylinder—a body of roller-like form.

Deceased—dead.
Deliriant—an agent causing delirium.
Delirium—a fever of the brain.
Demulcent—a substance used to soften and soothe.
Deodorants—substances that destroy foul odors.
Deodorizer—a substance used to disinfect and to deprive of odor.
Depressant—a substance that lessens activity, generally lowering the spirit.
Depression—low in spirits.
Detergents—substances used to clean the skin and wounds.
Diaphoretics—substances used to cause perspiration.
Diarrhea—a frequent purging of the bowels.
Dilate—to increase or widen in all directions.
Dilute—to diminish the strength of by mixing.
Disinfect—to free from contagious matter.
Disinfectant—a substance used to free from contagious matter.
Dissolution—the act of dissolving; breaking up; decomposition.

Dissolved—to make a solution of.

Distillation—the process of heating a mixture until one or more components become vapor (the vapor is later condensed to a liquid again).

Distilled—the substance resulting from distillation.

Dose—quantity of medicine taken at one time. See page 13.

Dram—the eighth part of the apothecaries' table or fluid ounce.

Drug habit—a condition in which there is a tendency to repeat the use of drugs for personal pleasure.

Dyspnea—difficult or labored breathing.

Edema—accumulation of serum in the cellular tissue.

Edible—fit to eat; capable of being eaten.

Efficiency—capability.

e.g.—for example.

Electrolysis—the separation of a compound into its several parts by electricity.

Element—a substance that cannot be analyzed or broken down into other substances by ordinary chemical methods.

Eliminated—left out; expelled from the system.

Emetic—a solution used to induce vomiting. See page 24.

Epigastric—pertaining to the abdominal region.

Epigastrium—a region of the abdomen.

Erroneously—erring; mistaken; misleading.

Eruption—act of bursting forth.

Escharotic—a caustic; a substance that destroys the skin it contacts.

Esophagus—the canal, about 9 inches in length, extending from the pharynx to the stomach.

Etc.—and so forth.

Evacuate—to withdraw from; to make empty, to empty out.

Evacuation—act of withdrawing.

Evaporate—to pass off in vapor.

Exhaustion—the state or process of being completely weary.

Exhilaration—animation; unusual gaiety.

Expectorant—a substance that increases the discharge of mucous or other fluids from the lungs and throat.

Extract—to pull or draw out of (verb); that which is extracted or gotten out of a mixture (noun).

Extremities—arm or legs; terminal end of any organ, hands or feet.

Exudation—a discharging through the pores.

Fabric—textiles; material.

Fatal dose—the smallest amount that is known to have caused death of an adult.

Feces—excrement; dung; the discharge of the bowels.

Fermentation—the decomposition produced in an organic substance, such as the decomposition of sugar by yeast, or of tissue by bacteria.

Filter—a strainer; an apparatus used for clearing or purifying liquids.

Filtrate—the liquid portion that runs through the filter, as distinguished from the solid precipitate that remains on the filter.

Filtration—the process of removing suspended matter from a liquid by passing it through something porous.

Flakes—scalelike particles, as of snow.

Flexible—easily bent; pliant; supple.

Fluid—gases as well as liquids are considered fluids; in this book the term is confined to liquids.

Formula—a group of symbols, expressing the composition of a chemical compound.

Fumes—to send forth as smoke and vapor (verb); the smoke or vapor (noun).

Fumigant—a substance used to disinfect or purify by the action of vapor or smoke.

Fumigating—act of using fumes or vapor to purify from infection.

Functioning—performing a duty.

Fungus growth—one of the nongreen plants, including bacteria, mushrooms, toadstools, etc. that feed upon organic matter.

Fusible—capable of being melted or liquefied.

Fusion—the act of melting, or state of being melted; the blending together of things.

Gaseous—in the form of gas.
Generated—produced; originated by chemical or physical processes.
Genitals—organs of generation or reproduction.
Germicidal—pertaining to substances that destroy bacteria.
Germicide—any substance used to kill bacteria.
Glucosides—any member of a series of compounds that may be resolved by an acid into glucose (a sugar) and another principle.
Grain—the twentieth part of a scruple in apothecaries' weight.
Gram—the weight of a cubic centimeter of pure water at its maximum density, which is reached at 3.98° C.
Granular—consisting of grains.
Granules—small particles.
Gums—juices that exude from trees and thicken on the surface.

Hallucinations—wanderings of the mind.
Havoc—devastation.
Hemoglobin—a substance contained in the red corpuscles of the blood that gives the blood its color and combines with oxygen in the lungs.
Homicide—the killing of one person by another.
Horizontal—parallel to the horizon.
Hormones—substances contained in a glandular secretion that affect the functioning of various parts of the body.
Hygroscopic—having the property of absorbing moisture from the air.
Hypnotic—tending to produce sleep.
Hypodermic—medicine introduced under the skin.
Hypodermically—by giving to parts under the skin, by introduction under the skin.
Hysteria—uncontrollable emotional excitement.

Idiosyncrasy—individual; characteristic; peculiar.
Incapacitation—state of being unfit; lack of physical or intellectual power.
Induce—to lead by persuasion or argument; bring on.
Infection—tainted with disease; poisoned; contagion.
Inflammable—easily set on fire.

Inflammation—a redness and swelling of any part of the body accompanied by heat and pain.
Ingested—having taken into the stomach.
Ingestion—act of taking into the stomach.
Ingredient—a component part of any mixture; an element.
Inhalation—the breathing in of air.
Inhalator—a device aiding supply of oxygen to patient.
Insecticides—substances used for killing bugs, flies, and other insects.
Insoluble—incapable of being dissolved.
Intense—extreme in degree.
Intestines—the canal or tube extending from the stomach down.
Intolerant—not allowing difference of opinion or belief to others; unable to bear or endure.
Intravenously—into the veins by injection.
Irritant—that which irritates.
Irritative—exciting or provocative; a substance that increases action.

Jaundice—a disease characterized by yellowness of the eyes and skin, and caused by a suffusion of bile.

Laboratory—a place for scientific operations and experiments.
Laryngeal—pertaining to the larynx.
Larynx—the upper part of the windpipe; a cavity containing the vocal cords.
Lethal—mortal; deadly.
Lucifer—a wood match tipped with a substance that is ignited by friction.
Luminal—trade name for a hypnotic; pertaining to the lumen of a blood vessel.
Luminous—bright; lustrous; giving forth or spreading light.
Luster—brightness; shine from reflected light; gloss.
Lustrous—bright; glossy; shiny.

Malleable—capable of being worked or extended by beating.
Mania—madness; unreasonableness.

Maniacal—raving with madness.
Medium—that in which anything moves or through which it acts.
Metallic—pertaining to, or resembling, a metal.
Mg.—abbreviation for milligram.
Milligrams—thousandth part of a gram; .0154 of a grain.
Minims—one sixtieth part of a dram; a single drop.
Morbid—sickly; unhealthy; caused by disease.
Mortality—death or death rate.
Mucous membrane—the lining of the canals and cavities of the body.
Mutilate—maim; to destroy by removing an essential part.

Narcotic—a drug producing sleep.
Nausea—to become sick with a desire to vomit.
Necrosis—gangrene, especially of the bone.
Neurologic—pertaining to the nervous system.
Neutralize—to render inactive; to destroy the characteristics of by chemical means or combination.
Nontoxic—not poisonous.
Notoriety—the state of being well known, especially in an undesirable sense.
Noxious—deadly; harmful; injurious.

Obesity—excessive fatness.
Octahedral—a form containing eight triangles.
Oleoresins—a natural mixture of resins and volatile essential oils.
Opaque—not transparent; not allowing light to pass through.
Optic nerve—the nerve running from the eye to the optic centers of the brain.
Organic—pertaining to a living organ or organs.
Oxide—a compound of oxygen and another element.
Oxidize—combine with oxygen or any other nonmetal.
Oxidizing—the act or process of becoming oxidized.
Oxidizing agent—any substance that causes other substances to oxidize.

Pallor—paleness; wanness.
Palpitation—a violent beating of the heart.

Pancreas—a gland in the abdomen beneath the stomach.
Paralysis—loss of voluntary motion or sensation in any part of the body.
Paralyzing—impairing the action or energy of.
Parasites—plants or animals that live at the expense of another.
Pathogenic bacteria—bacteria causing disease.
Pellets—little balls.
Persevering—continuing steadfastly in any business or enterprise.
Perspiration—act or process of sweating; also sweat, the saline fluid given off in the process.
Pharynx—cavity forming back part of mouth and ending in the esophagus.
Pigments—coloring matter, as in paints, tissue, or other bodies.
Pliable—easy to bend; yielding; flexible.
Polluted—fouled; unclean; corrupted.
Post mortem—after death.
Ppm.—abbreviation for part per million. See page 125.
Precipitate—insoluble substance formed in a solution by chemical reaction.
Preservatives—substances that prevent decay.
Prism—a solid whose two ends are identical in size and shape, and parallel; and whose sides are parallel four-sided figures.
Processes—a series of actions or experiments.
Profound—deeply felt.
Prolonged—lengthened out; put off to a distant time; extended.
Pungent—acrid; sharply affecting the taste or smell; sharply painful.
Purging—free evacuation of the bowels.

Rapidity—swiftness; quickness.
Reacts—in chemistry, to undergo a chemical change.
Reagent—anything used to carry out a test.
Rectum—terminal part of the large intestine.
Reflexes—nerve impulses directed back without taking time to travel to the brain, such as the protective action that instantly lifts the hand when it touches a hot stove.
Refrigerant—a cooling substance.

Resin—hardened sap that exudes from trees and plants.
Resinous—partaking of the qualities of resin.
Respiration—the act of breathing.
Respiratory failure—failure to breathe.
Respiratory tract—the area serving for respiration.
Retard—hinder; delay.
Retching—attempting to vomit.
Rigid—not easily bent; stiff.
Rigidity—want of pliability; property of resisting change in shape.
Rigor—state of being rigid.
Rigor mortis—stiffening of the body after death.

Saccharated—sweetened.
Salicylate—a salt of salicylic acid.
Saline—containing salt; salty quality.
Salivation—process of producing an excessive secretion of saliva.
Salt—a product formed by neutralization of any acid with any base; commonly applied to sodium chloride (ordinary table salt).
Saponins—an expectorant, emetic, and alterative glucosid from *Saponaria officinalis.*
Sardonic—forced, heartless, mocking; as of a laugh or smile.
Saturated—soaked; pertaining to or describing a solution containing as much dissolved material as is possible at the given temperature.
Saturation—act of soaking.
Secretion—the matter secreted, or separated and discharged by a cell or cells, e.g., milk or saliva.
Sedative—a remedy that allays irritability or pain.
Sensory nerve—a nerve transmitting impulses from the periphery to the center.
Sequence—order of succession.
Shellac—crude lac melted into plates or cakes for varnish.
Solid—not liquid or fluid; not hollow; dense.
Soluble—capable of solution.
Solution—reduction of a body to a fluid state by combination with a liquid.

Solvent—a substance having the power of dissolving another substance.

Spasm—an involuntary contraction of muscles.

Specimen—an individual; a sample.

Stability—the state or quality of being stable or firm.

Stagnation—the state of being stale or foul from long standing.

Stimulant—a substance inciting and producing vital action.

Stimulates—rouses to activity; produces a temporary increase of vitality or activity.

Stimulation—the act of exciting or producing a temporary increase of vitality or energy.

Stomach tube—a flexible tube for irrigation or evacuation of the stomach.

Stools—discharge from the bowels.

Stupor—numbness; senselessness.

Styptic—an agent that checks hemorrhage by causing contraction of the blood vessels.

Subacetate—an acetate that has the OH group within it, e.g., cupric subacetate $Cu(OH)(C_2H_3O_2)$.

Subacute—moderately acute.

Subcutaneously—beneath the skin.

Sublimable—capable of being sublimed.

Sublimate—a substance that has been sublimed; to purify.

Sublime—to pass directly from the solid to the gaseous state; iodine sublimes.

Subnormal—under normal.

Substance—the material of which anything is composed.

Suicidal—ruinous, self-destructive.

Suicide—self-murder.

Susceptibility—capacity for taking up, of having little resistance to a disease, poison, etc.

Susceptible—yielding readily, liable, sensitive, likely to take up.

Suspended—caused to cease for a time; supported, as a dust in air, or a solid in liquid.

Synthesis—the uniting of elements to form a compound.

Synthetically—by or based on synthesis, or on the putting of elements together in a new form.

Systemic—pertaining to the whole body.

Tannins—principles of oak bark and other trees.
Tetanic—pertaining to or resembling tetanus (a disease characterized by spasmodic and continuous contraction of the muscles).
Tissue—the texture of elements of which any part of the body is composed.
Tolerance—ability to endure a poison or a drug that may be harmful if taken in excess.
Toxemia—blood poisoning.
Toxic—poisonous.
Toxicity—state of being toxic.
Toxicologic—dealing with poisons.
Toxicology—the branch of medicine dealing with poisons.
Toxin—a poisonous substance.
Trachea—windpipe, the main tube by which air goes to and from the lungs.
Tract—an area.
Transfusion—a transfer of blood into the veins.
Translucent—semitransparent; permitting passage of light without clear vision of objects beyond.
Trunk—the body without head, arms or legs.

Ulcer—an open sore, containing pus, on the external or internal surface of the body.
Urethra—the canal by which the urine is discharged.
Urine—a fluid secreted by the kidneys.
U.S.P.—abbreviation for United States Pharmacopoeia.

Vagina—the canal extending from the vulvar opening to the cervix uteri.
Vapor—visible moisture or steam.
Variable—changeable.
Vascular—consisting of, pertaining to, or provided with vessels, as blood vessels.
Ventilation—replacement of used air; the act of supplying fresh air.
Vermin—objectionable small animals or insects as rats, mice, etc.

Vertigo—dizziness; giddiness.
Volatile—having the power of evaporating.
Volatilize—to convert into vapor by means of heat.
Vomiting—throwing up; ejecting contents of the stomach via the mouth.
Vomitus—the matter ejected from the stomach.

Analytical Reagents

Most substances are required in water solutions. To prepare these, place the amount of substance indicated below in a 100 cc. volumetric flask; dissolve in distilled water; and finally dilute to the mark. This gives 100 cc. of a solution of 1 molar concentration, excepting in special cases, which are noted.

Acetic acid, glacial
Acetic acid, dilute (29 cc. of glacial acetic acid = 5 Normal)
Ammonium carbonate [57 g. $(NH_4)_2CO_3 \cdot H_2O$]
Ammonium hydroxide, dilute (33 cc. conc. NH_4OH = 5 Normal)
Ammonium oxalate [8 g. $(NH_4)_2C_2O_4 \cdot H_2O$]
Ammonium sulfide, colorless, aq.
Ammonium vanadate, see Mandelin's reagent
Aniline

Barium chloride (12.2 g. $BaCl_2 \cdot 2H_2O$)
Benzidine (saturated solution, as much as will dissolve in glacial acetic acid)
Bromine, liquid
Bromine (2 cc. = 2% solution)

Calcium chloride (10 g. $CaCl_2 \cdot 6H_2O$)
Calcium hypochlorite (solid $CaOCl_2$ only; just before use dissolve 5 g. in 95 cc. water = 5% solution)
Calcium oxide (0.05 g., then filter; clear solution is limewater)
Chlorine water (saturated solution)
Chloroform
Copper foil, arsenic-free
Cupric acetate [3 g. $Cu(C_2H_3O_2) \cdot H_2O$ = 3% solution]

Ether
Ethyl alcohol (95% C_2H_5OH)

Ferric chloride (27 g. $FeCl_3 \cdot 6H_2O$)
Formaldehyde (formalin, 40% solution)
Frohde's reagent (0.2 g. molybdic acid in 100 cc. conc. H_2SO_4)

Hydrobromic acid
Hydrochloric acid, arsenic-free, conc. (sp. gr. 1.19)
Hydrochloric acid, dil. (41.6 cc. conc. HCl = 5 Normal)
Hydrogen peroxide (3% solution)

Iodic acid
Iodine, Tincture of

Lead acetate paper

Magnesium nitrate [about 23 g. $Mg(NO_3)_2 \cdot 6H_2O$, as much as will dissolve; then make alkaline to litmus paper with MgO]
Magnesium oxide, see Magnesium nitrate
Mandelin's reagent (1 g. ammonium vanadate in 54 cc. conc. H_2SO_4)
Manganese dioxide, solid
Manganous chloride (19.8 g. $MnCl_2 \cdot 4H_2O$)
Mayer's reagent (1.36 g. $HgCl_2$ + 5 g. KI in 100 cc. water)
Mercuric chloride, see Mayer's reagent
Mercury, see Millon's reagent
Methyl orange (2.5 g. in water = 2.5% solution)
Millon's reagent (5g.Hg + 5 cc. fuming nitric acid + 10 cc. H_2O)
Molybdic acid; see Frohde's reagent

Naphthol, beta (5 g. in 120 cc. ethyl alcohol = 5% solution)
Nitric acid, fuming
Nitric acid, conc. (sp. gr. 1.42)
Nitric acid, dil. (22.2 cc. conc. HNO_3 = 5 Normal)

Palladous chloride (2 g. $PdCl_2 \cdot 2H_2O$ = 2% solution)
Phenol (as much as will dissolve in water, about 8 g.)
Phenyl hydrazine hydrochloride (5 g. = 5 % aq. solution)
Phosphoric acid, syrupy
Potassium dichromate, crystals ($K_2Cr_2O_7$)

Potassium dichromate (29.4 g. $K_2Cr_2O_7$)
Potassium ferrocyanide (10.6 g. $K_4Fe(CN)_6 \cdot 3H_2O$)
Potassium hydroxide (5.6 g. KOH)
Potassium iodide (16.6 g. KI; also for Mayer's reagent)
Potassium nitrite (8.5 g. KNO_2)
Potassium permanganate (15.8 g. $KMnO_4$)
Pyridine

Resorcinol [11 g. $C_6H_4(OH)_2$]

Silver nitrate (1.7 g. $AgNO_3$ = 0.1 Molar)
Sodium bicarbonate (8.4 g. $NaHCO_3$, baking soda)
Sodium carbonate (28.6 g. $Na_2CO_3 \cdot 10H_2O$, washing soda)
Sodium hydroxide (4.0 g. NaOH)
Sodium molybdate (24.2 g. $Na_2MoO_4 \cdot 2H_2O$)
Sodium nitrate (8.5 g. $NaNO_3$)
Sodium nitroprusside [0.5 g. $Na_2Fe(CN)_5NO \cdot 2H_2O$ = 0.5% solution]
Sodium oxalate (13.4 g. $Na_2C_2O_4$)
Stannous chloride, crystals (make up fresh solution by adding 22.5 g. $SnCl_2 \cdot 2H_2O$ to 100 cc. water)
Starch iodide paper
Sulfuric acid, conc. (sp. gr. 1.84)
Sulfuric acid, dil. (Care! add 13.3 cc. conc. H_2SO_4 to water, with stirring = 5 Normal)

Vanillin (1 g. in 90 cc. conc. HCl = 1% solution)

Zinc, mossy, arsenic-free

APPARATUS

1 gross 30 cc. dropping bottles for reagents above
1 Alcohol burner
5 beakers, 50 cc.
5 beakers, 250 cc.
2 volumetric flasks, 100 cc.
5 ft. glass rod, 5 mm.
5 ft. glass tubing, 6 mm. o.d.

1 doz. test tubes, small
3″ platinum wire, about 0.01″ diameter
2 10 cc. graduated cylinders
2 100 cc. graduated cylinders
1 pkg. filter paper, qualitative, 11 cm.
1 test tube clamp
1 test tube rack
2 funnels, glass, 40 mm., short stem
Glass wool
Cotton, paper towels, matches, wood splints, etc.

TABLE OF WEIGHTS AND MEASURES

TROY WEIGHT

1 pound = 22.816 cubic inches of distilled water at 62° F.

Grains		Dwt.		Ounce		Pound
24	=	1				
480	=	20	=	1		
5760	=	240	=	12	=	1

AVOIRDUPOIS WEIGHT

1 pound avoirdupois = 1.2153 pounds troy

Grains (gr.)		Drams (dr.)		Ounces (oz.)		Pound (lb.)
27.34375	=	1				
437.5	=	16	=	1		
7000	=	256	=	16	=	1

APOTHECARIES' WEIGHT

Grains (gr.)		Scruples (℈)		Drams (ʒ)		Troy Ounces (oz.)		Pound (lb.)
20	=	1						
60	=	3	=	1				
480	=	24	=	8	=	1		
5760	=	288	=	96	=	12	=	1

APOTHECARIES' MEASURE

Minims (♏)		Fluid drams (f3)		Fluid ounces (f℥)		Pints (O)		Gallons (C)
60	=	1						
480	=	8	=	1	=			
7,680	=	128	=	16	=	1		
61,440	=	1024	=	128	=	8	=	1

IMPERIAL MEASURE

Minims		Fluid drams		Fluid ounces		Pints		Gallons
60	=	1	=					
480	=	8	=	1				
9,600	=	160	=	20	=	1		
76,800	=	1280	=	160	=	8	=	1

HOUSEHOLD UTENSILS

(approximate)

20 grains	About the quantity of solid that that can be piled on a 25-cent piece
1 dram or 4 grams	About 1 level teaspoonful
2 drams or 8 grams	About I level dessertspoonful
4 drams or 16 grams or ½ ounce	About 1 level tablespoonful
8 ounces or 240 cc.	About 1 tumblerful

UNITED STATES COIN WEIGHTS

(approximate)

One 50¢ piece	=	12.5	grams	=	200	grains	= (avoir.)
One 25¢ piece	=	6.25	grams	=	100	grains	= (avoir.)
One 10¢ piece	=	2.5	grams	=	40	grains	= (avoir.)
One 5¢ piece	=	5	grams	=	80	grains	= (avoir.)
One 1¢ piece	=	3.1	grams	=	50	grains	= (avoir.)
One 10¢ piece + two 50¢ pieces				=	27.5	grams	= 440 grains, or about 1 ounce

TROY EQUIVALENTS OF METRIC DOSES

0.1 gm.	(1 decigram)	Over	1½ grains
0.2 gm.	(2 decigrams)	Over	3 grains
0.3 gm.	(3 decigrams)	Over	4½ grains
0.6 gm.	(6 decigrams)	Over	9 grains
1 gm.	(1 gram)	Over	15 grains
2 gms.	(2 grams)	Over	30 grains

Grains	*Milligrams*	*Grams*
1	65	0.065
$\frac{1}{2}$	32	0.032
$\frac{1}{4}$	16	0.016
$\frac{1}{8}$	8.0	0.008
$\frac{1}{16}$	4.1	0.0041
$\frac{1}{20}$	3.2	0.0032
$\frac{1}{25}$	2.6	0.0026
$\frac{1}{30}$	2.2	0.0022
$\frac{1}{40}$	1.6	0.0016
$\frac{1}{50}$	1.3	0.0013
$\frac{1}{60}$	1.1	0.0011
$\frac{1}{64}$	1.0	0.0010
$\frac{1}{100}$	0.65	0.00065
$\frac{1}{120}$	0.54	0.00054
$\frac{1}{150}$	0.43	0.00043
$\frac{1}{200}$	0.32	0.00032
$\frac{1}{600}$	0.11	0.00011

EXACT MEASUREMENTS

An example best illustrates how to use the following tables. To convert 5 gallons into pints, look for gallons on the vertical line; now move along horizontally from this to the space under pints. The number in this space is 8. From this we calculate that 5 gallons is equal to $5 \times 8 = 40$ pints.

SOLID WEIGHT
(Troy, Apothecary, and Metric)

	dram (troy)	grain	gram	ounce (troy)	pound (troy)	scruple
1 Dram (Troy) =	.....	60	3.89	0.125	$\frac{1}{96}$	3
1 Grain =	0.0167	.....	0.0648	0.00208	$\frac{1}{5760}$	0.050
1 Gram =	0.257	15.43	.....	0.2322	0.00268	0.772
1 Ounce (Troy) =	8	480	31.1	.....	$\frac{1}{12}$	24
1 Pound (Troy) =	96	5760	373.2	12	.....	288
1 Scruple =	0.333	20	1.30	0.0417	0.00347	.....

LIQUID MEASURE
(Troy and U. S. Fluid)

	cc.	dram U. S. fluid	gallon U. S. fluid	minim U. S. fluid	ounce U. S. fluid	pint U. S. liquid	quart U. S. liquid
1 cc. =	.....	0.271	0.0002	16.2	0.0338	0.00211	0.00106
1 dram (fluid) =	3.70	.....	0.00098	60	0.125	0.00781	0.00391
1 gallon (fluid) =	3785	1024	.....	61440	128	8	4
1 minim (fluid) =	0.0616	$\frac{1}{60}$	0.0000163	.....	$\frac{1}{480}$	0.00013	0.000065
1 ounce (fluid) =	29.6	8	$\frac{1}{128}$	480	.....	$\frac{1}{16}$	0.0313
1 pint (liquid) =	473.2	128	0.125	7680	16	.....	0.5
1 quart (liquid) =	946.4	256	0.25	15360	32	2	.....

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